

The EPA Administrator signed the following proposed rule on April 30, 2002. It is being submitted for publication in the *Federal Register*. While EPA has taken steps to ensure the accuracy of this Internet version of the rule, it is not the official version of the rule for purposes of public comment. Please refer to the official version in a forthcoming *Federal Register* publication and on GPO's Web Site. The rule will likely be published in the *Federal Register* in mid-May 2002. You can access the *Federal Register* at: [http://www.access.gpo.gov/su\\_docs/aces/aces140.html](http://www.access.gpo.gov/su_docs/aces/aces140.html). When using this site, note that "text" files may be incomplete because they don't include graphics. Instead, select "Adobe Portable Document File" (PDF) files.

**ENVIRONMENTAL PROTECTION AGENCY**  
**40 CFR part 94**  
**[AMS-FRL-     ]**

**RIN 2060-AJ98**

**Control of Emissions of Air Pollution from New Marine Compression-Ignition Engines at or Above 30 Liters/Cylinder**

**AGENCY:** Environmental Protection Agency (EPA).

**ACTION:** Notice of Proposed Rulemaking.

**SUMMARY:** In this action, we are proposing emission standards for new marine diesel engines at or above 30 liters per cylinder and 2.5 to 30 liters per cylinder on U.S. vessels. Marine diesel engines at or above 30 liters per cylinder are very large marine engines used primarily for propulsion power on ocean-going vessels such as container ships, tankers, bulk carriers, and cruise ships. The vessels that use these engines are flagged in the United States and in other countries. Nationwide, these engines contribute to ozone and carbon monoxide nonattainment and to ambient particulate matter levels, particularly in commercial ports and along coastal areas.

We are proposing emission controls for these engines at or above 30 liters per cylinder on U.S. vessels. We are proposing a first tier that is equivalent to the internationally negotiated oxides of nitrogen standards and would be enforceable under U.S. law for new engines built in 2004 and later. We are also considering adoption of a subsequent second tier of standards, which would reflect additional reductions that can be achieved through engine-based controls, and would apply to new engines built after 2006 or later. In addition, we are proposing voluntary low-emission engine standards that reflect advanced oxides of nitrogen emission-control technologies. Meeting these standards would likely require the use of technologies such as selective catalyst reduction or fuel cells. If the second tier is promulgated, we would review the second tier standards prior to their effective date to take into consideration continued development of new technologies, such as selective catalyst reduction and water-based emission reduction techniques, and international activity such as action at the International Maritime Organization to set more stringent international standards. Consistent with these factors, EPA is also considering not adopting Tier 2 standards in this rulemaking, and instead establishing a schedule for a future rulemaking and addressing Tier 2 standards in that future rulemaking.

Emissions from all marine diesel engines at or above 30 liters per cylinder, regardless of flag of registry, currently account for about 1.5 percent of national mobile source oxides of nitrogen emissions. This contribution can be significantly higher on a port-specific basis (5 to 25 percent of mobile source emissions in certain key ports by the year 2020). The standards discussed in this notice, which would apply only to new engines on U.S. flag vessels, are expected to reduce these national emissions by about 11 percent by 2030.

The contribution of these engines to national mobile source hydrocarbon and carbon

monoxide inventories is small, less than 0.1 percent, and we are considering standards to ensure that these emissions do not increase on an engine-specific basis. The contribution of these engines to the national mobile source particulate matter inventory is about 2.6 percent. Reductions in particulate emissions could be obtained from setting a sulfur content standard for the fuels that are used by these engines, and we request comment on whether we should adopt such standards and, if so, the level of sulfur that should be allowed.

We are also proposing new requirements for engines at or above 2.5 liters per cylinder but less than 30 liters per cylinder. The Tier 2 standards finalized for these engines in our 1999 commercial marine diesel engine rule apply beginning in 2007. Until then, engine manufacturers are encouraged to voluntarily comply with the Tier 1 standards, which are equivalent to the internationally negotiated NOx standards. The international NOx standards are not yet enforceable. Given that they have not yet entered into force, we believe it is appropriate to begin to require engine manufacturers to certify these engines to the Tier 1 standards, starting in 2004. We are also proposing to eliminate the foreign trade exemption for all marine diesel engines, which was available for engines installed on vessels that spend less than 25 percent of total operating time with 320 kilometers of U.S. territory.

The proposed standards would apply to engines installed on vessels flagged in the United States. Recognizing that foreign-flag vessels constitute a significant portion of emissions from these engines, we are seeking comment on whether the proposed standards and existing Category 1 and Category 2 standards should also apply to marine engines on foreign vessels entering U.S. ports and to no longer exclude such foreign vessels from the emission standards under 40 CFR 94.1(b)(3). If we were to determine that the standards should apply to engines on foreign vessels that enter U.S. ports, then all emission standards for marine diesel engines would apply, including those we finalized for marine diesel engines less than 30 liters per cylinder in our 1999 rule.

**DATES:** *Comments:* Send written comments on this proposed rule by July 16, 2002. See Section IX.A for more information about written comments.

*Hearing:* We will hold a public hearing on June 13, 2002 at the Hyatt Regency Long Beach, California. See Section IX.B for more information about the public hearing.

**ADDRESSES:** *Comments:* You may send written comments in paper form or by e-mail. We must receive them by the date indicated under DATES above. Send paper copies of written comments (in duplicate, if possible) to the contact person listed below. You may also submit comments via e-mail to “[c3marine@epa.gov](mailto:c3marine@epa.gov).” In your correspondence, refer to Docket A-2001-11. See Section IX.A for more information on comment procedures.

*Docket:* EPA’s Air Docket makes materials related to this rulemaking available for review in Public Docket A-2001-11 at the following address: U.S. Environmental Protection Agency (EPA), Air Docket (6102), Room M-1500 (on the ground floor in Waterside Mall), 401 M Street, S.W., Washington, DC 20460 between 8 a.m. to 5:30 p.m., Monday through Friday, except on government holidays. You can reach the Air Docket by telephone at (202)260-7548, and by

facsimile at (202)260-4400. We may charge a reasonable fee for copying docket materials, as provided in 40 CFR part 2.

*Hearing:* We will hold a public hearing on June 13, 2002 at the Hyatt Regency Long Beach, California (562-491-1234). If you want to testify at the hearing, notify the contact person listed below at least ten days before the date of the hearing. See Section IX.B for more information on the public hearing procedures.

**FOR FURTHER INFORMATION CONTACT:** Margaret Borushko, U.S. EPA, National Vehicle and Fuels Emission Laboratory, 2000 Traverwood, Ann Arbor, MI 48105; Telephone (734)214-4334; Fax: (734)214-4816, E-mail: borushko.margaret@epa.gov.

#### **SUPPLEMENTARY INFORMATION:**

##### **Affected Entities**

This proposed action would affect companies and persons that manufacture, sell, or import into the United States new marine compression-ignition engines for use on vessels flagged or registered in the United States; companies and persons that make vessels that will be flagged or registered in the United States and that use such engines; and the owners/operators of such U.S.-flag vessels. We are inviting comment on including foreign flagged vessels. Further requirements apply to companies and persons that rebuild or maintain these engines. Affected categories and entities include:

Category	NAICS Code <sup>a</sup>	Examples of potentially affected entities
Industry	333618	Manufacturers of new marine diesel engines
Industry	336611	Manufacturers of marine vessels
Industry	811310	Engine repair and maintenance
Industry	483	Water transportation, freight and passenger
Industry	324110	Petroleum refineries
Industry	422710, 422720	Petroleum Bulk Stations and Terminals; Petroleum and Petroleum Products Wholesalers

<sup>a</sup>North American Industry Classification System (NAICS)

This list is not intended to be exhaustive, but rather provides a guide regarding entities likely to be affected by this action. To determine whether particular activities may be affected by this action, you should carefully examine the proposed regulations. You may direct questions regarding the applicability of this action to the person listed in **FOR FURTHER INFORMATION CONTACT**.

## Additional Information about this Rulemaking

Emission standards for new marine diesel engines at or above 30 liters per cylinder were considered by EPA in two previous rulemakings, in 1996 and in 1999. The notice of proposed rulemaking for the first rule (for the control of air pollution from new gasoline spark-ignition and diesel compression-ignition marine engines) can be found at 59 FR 55930 (November 1994); a supplemental notice of proposed rulemaking can be found at 61 FR 4600 (February 7, 1996); and the final rule can be found at 61 FR 52088 (October 4, 1996). The notice of proposed rulemaking for the second rule (for the control of air pollution from new compression-ignition marine engines at or above 37 kW) can be found at 63 FR 68508 (December 11, 1998); the final rule can be found at 64 FR 73300 (December 29, 1999). These documents are available on our websites, <http://www.epa.gov/otaq/marine.htm> and <http://www.epa.gov/otaq.marinesei.htm>. This proposal relies in part on information that was obtained for those rulemakings, which can be found in Public Dockets A-92-28 and A-97-50. Those dockets are incorporated by reference into the docket for this proposal, A-2001-11.

## Obtaining Electronic Copies of the Regulatory Documents

The preamble, regulatory language, Draft Regulatory Support Document, and other rule documents are also available electronically from the EPA Internet Web site. This service is free of charge, except for any cost incurred for internet connectivity. The electronic version of this proposed rule is made available on the date of publication on the primary web site listed below. The EPA Office of Transportation and Air Quality also publishes **Federal Register** notices and related documents on the secondary web site listed below.

1. <http://www.epa.gov/docs/fedrgstr/EPA-AIR> (either select desired date or use Search features).
2. <http://www.epa.gov/otaq> (look in What's New or under the specific rulemaking topic)

Please note that due to differences between the software used to develop the documents and the software into which the document may be downloaded, format changes may occur.

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### **I. Introduction**

#### **A. Overview**

Marine diesel engines can be significant contributors to local ozone, CO, and PM levels, particularly in commercial ports and along coastal areas. In recognition of their inventory impact, we recently set emission standards for new marine diesel engines above 37 kW but less than 30 liters per cylinder (64 FR 73300, December 29, 1999). The standards contained in that rule cover emissions of oxides of nitrogen (NO<sub>x</sub>), particulate matter (PM), hydrocarbons (HC), and carbon monoxide (CO), and go into effect in 2004-2007, depending on engine size. Those standards are more stringent than the international standards contained in Annex VI to the International Convention on the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978 Relating Thereto (this convention is also known as MARPOL; the standards are referred to as the Annex VI NO<sub>x</sub> limits).<sup>1</sup> They also cover more pollutants, as the MARPOL limits are for NO<sub>x</sub> emissions only. As described in Section D, below, the Annex has not yet gone into force because the requisite number of countries have not ratified it. Prior to the effective date of the national standards, engine manufacturers are encouraged to voluntarily comply with the Annex VI NO<sub>x</sub> limits pending entry into force of Annex VI. We developed a voluntary certification program to enable engine manufacturers to certify to the Annex VI NO<sub>x</sub> limits prior to the Annex VI requirements entering into force. The national emission requirements apply only to engines on vessels flagged in the United States. Marine engines on foreign vessels were not covered by the rule.

We did not set standards for new marine diesel engines at or above 30 liters per cylinder in

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<sup>1</sup>Annex VI was adopted by a Conference of the Parties to MARPOL on September 26, 1997, but has not yet entered into force. Copies of the conference versions of the Annex and the NO<sub>x</sub> Technical Code can be found in Docket A-95-50, Document II.B.01. Copies of updated versions can be obtained from the International Maritime Organization (<http://www.imo.org>)

our 1999 rule. Our analysis at the time indicated that the Annex VI NO<sub>x</sub> limits were appropriate given the operating characteristics and fuel used by these engines. Rather than duplicate the Annex VI emission control program in our federal regulations, we encouraged engine manufacturers to comply with the Annex VI limits using our voluntary certification program. We also indicated that we would revisit the need to adopt emission limits for these engines under the Clean Air Act if the Annex does not go into effect internationally.

Although more than four years have gone by since Annex VI was adopted by the Parties to the Convention, it has not yet entered into force. There is growing concern in the United States that there are no enforceable standards for these large marine engines. Also, recently developed inventories suggest that the inventory contribution of these engines can be very high in individual port areas. We estimate that these engines account for about 1.5 percent of national mobile source NO<sub>x</sub> emissions. This contribution can be significantly higher on a port-specific basis. For example, we estimate that these engines contribute about 7 percent of mobile source NO<sub>x</sub> in the Metropolitan Statistical Areas (MSA) of Baton Rouge/New Orleans and Wilmington NC, about 5 percent of mobile source NO<sub>x</sub> in the Miami/ Fort Lauderdale and Corpus Christi MSAs, and about 4 percent in the Seattle/Tacoma/Bremerton/Bellingham MSA. In addition, these ships can have a significant impact on inventories in areas without large commercial ports. For example, Santa Barbara estimates that engine on ocean-going marine vessels contribute about 37 percent of total NO<sub>x</sub> in their area. These emissions are from ships that transit the area, and “are comparable to (even slightly larger than) the amount of NO<sub>x</sub> produced onshore by cars and truck.”<sup>2</sup> These emissions are expected to increase to 62 percent by 2015.

We estimate the contribution of these engines to national PM levels is about 2.6 percent, but can also be higher on a port-specific area (see Table 2.6-1 in the draft Regulatory Support Document (RSD) for this rule and associated text). The estimated contribution of these engines to national HC and CO emissions is negligible. The inventory contribution of these engines to national NO<sub>x</sub>, PM, HC, and CO levels is expected to increase as emissions from other mobile sources decrease due to our recently finalized emission control programs for highway vehicles and heavy-duty trucks. Reductions in the inventories of these pollutants will lead to health benefits, as described in Section II.

In addition, manufacturers of diesel engines, including marine diesel engines, have gained greater experience with the emission control technologies that can be applied to these engines. Our analysis indicates that greater emission reductions can be achieved by optimizing currently available control technologies that are being used to achieve the Annex VI NO<sub>x</sub> limits.

This Notice discusses two tiers of NO<sub>x</sub> emission controls for these engines. The first tier is equivalent to the internationally negotiated NO<sub>x</sub> standards and would be enforceable under U.S. law for new engines built in 2004 and later. The second tier of NO<sub>x</sub> standards, if implemented,

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<sup>2</sup>Memorandum to Docket A-2001-11 from Jean Marie Revelt, “*Santa Barbara County Air Quality News*, Issue 62, July-August 2001 and other materials provided to EPA by Santa Barbara County,” March 14, 2002. Air Docket A-2001-11, Document No. II-A-47.



would reflect additional reductions that can be achieved through engine-based emission controls, and would apply to new engines built after 2006 or later. We are also considering standards for HC and CO emissions to ensure that these emissions do not increase on an engine-specific basis. Particulate matter emissions from these engines are primarily due to the characteristics of the fuel they use (residual fuel), and we are requesting comment on whether we should consider a sulfur content limit for that fuel. We would review the Tier 2 standards prior to their effective date to take into consideration continued development of new technologies, such as selective catalyst reduction and water-based emission reduction techniques, and international activity such as action at International Maritime Organization (IMO) to set more stringent international standards.

Consistent with our 1999 commercial marine diesel engine standards, this proposal also contains voluntary low emission standards for marine diesel engines at or above 30 liters per cylinder. As emissions from most mobile source categories continue to decline, emissions from marine vessels and associated port equipment are becoming an increasingly significant source of local, regional, and global emissions. Because of the slow turnover of vessels and associated equipment, there is an opportunity and need for the ports, shipping companies, engine manufacturers, and fuel suppliers to work on a collaborative effort to expedite and further reduce emissions beyond the Annex VI NO<sub>x</sub> limits and U.S. national standards. Two components of this proposal can help encourage these actions. The first is voluntary low emission standards set at 80 percent below the Annex VI NO<sub>x</sub> limits. These standards can be used in state-based initiatives and are expected to require the use of advanced technologies such as fuel cells or selective catalyst reduction. The second is the voluntary Blue Cruise program, in which participant vessel owners can receive special recognition from EPA for installing and using technologies that reduce waste and air emissions.

We are also proposing new requirements for engines at or above 2.5 liters per cylinder but less than 30 liters per cylinder. The Tier 2 standards we finalized for these engines in our 1999 commercial marine diesel rule are effective in 2007. Until then, and pending entry into force of Annex VI, we encouraged engine manufacturers to voluntarily comply with Tier 1 standards, which are equivalent to the internationally negotiated NO<sub>x</sub> standards. Because Annex VI has not gone into force, they remain unenforceable. Due to the continued uncertainty regarding entry into force of Annex VI, we believe it is appropriate to begin to require engine manufacturers to certify these engines to the Tier 1 standards, starting in 2004. We are also proposing to eliminate the foreign trade exemption for all marine diesel engines, which was available for engines installed on vessels that spend less than 25 percent of total operating time with 320 kilometers of U.S. territory. To date, this exemption has not been requested by engine manufacturers.

The standards discussed in this Notice, which would apply to engines installed on vessels flagged in the United States, are intended to help reduce ozone inventories and avoid a range of associated adverse health effects. The costs of the proposed Tier 1 standards are negligible and reflect certification and compliance costs only. We do not anticipate that there will be any engineering or design costs associated with the Tier 1 standards as manufacturers are already certifying engines to Annex VI requirements through our voluntary certification program. The estimated cost to industry of complying with the Tier 2 standards being considered is about \$115,000 per engine, with an additional estimated cost of about \$5,000 annually to maintain

equipment. This represents a 7 percent increase in the total engine cost and about 0.1 percent increase in the total vessel cost. We estimate the aggregate costs (annualized over 20 years) of the Tier 2 standards under consideration to be about \$1.6 million annually. The economic impacts and environmental benefits of the proposal and Tier 2 standards under consideration are described in Section VI, below.

The impact of the standards on air quality in specific areas will depend in part on the characteristics of the fleet of vessels that operate in that area, particularly on the proportion of foreign-flag ships to U.S.-flag ships. Recognizing that foreign-flag vessels constitute a significant portion of emissions from these engines and that the internationally negotiated NO<sub>x</sub> standards for these engines are not yet enforceable, we are seeking comment on whether the standards should also apply to marine engines on foreign vessels entering U.S. ports and to no longer exclude such foreign vessels from the emission standards under 40 CFR 94.1(b)(3). While EPA's current standards for marine vessels do not apply to foreign flag vessels, EPA is inviting comments on whether it should change this approach. If we were to apply our emission standards to foreign vessels that enter U.S. ports as part of this rulemaking effort, then the standards would apply to any marine engine that is manufactured after the standards become effective and that is installed on such a foreign vessel and would be a condition of port entry. The standards would also apply to any marine engine installed on such a foreign vessel that is manufactured (or that otherwise become new) after the standards become effective. While we are seeking comment on applying the standards to foreign vessels that use U.S. ports, we may require such standards for foreign vessels in 2003.

## **B. How Is This Document Organized?**

This document contains ten parts. After this introductory section, Section II describes the air quality need for this rulemaking and projected benefits. That section contains a description of the human health and welfare effects of exposure to ozone, PM, and CO and reports our inventory estimates for this source for current and future years. In Section III, we describe the set of engines that would be required to comply with the proposed standards and our reasoning behind this scope of application. Sections IV and VII contain the proposed emission standards and alternatives under consideration, effective dates, and testing requirements. We also discuss the technological feasibility of the standards discussed in this Notice, and alternative approaches. Section V describes various compliance provisions. Section VI summarizes the projected impacts of the standards and discusses their benefits. Section VIII describes a voluntary incentive program in which participant vessel owners can receive special recognition from EPA for installing and using technologies that reduce waste and air emissions. Finally, Sections IX and X contain information about public participation, how we satisfied our administrative requirements, and the statutory provisions and legal authority for this proposal. Additional information on many of these topics can be found in the Draft Regulatory Support Document for this proposal.

### **C. What Requirements Are We Proposing or Considering?**

The NO<sub>x</sub> emission standards for marine diesel engines at or above 30 liters per cylinder (Category 3 marine diesel engines) would consist of two tiers. Tier 1 would apply to new engines built in 2004 and later and would be equivalent to the Annex VI NO<sub>x</sub> limits adopted by the Parties to MARPOL in 1997. We are also considering Tier 2 NO<sub>x</sub> standards that would apply to new engines built after 2006 or later and consist of a NO<sub>x</sub> limit 30 percent below the Tier 1/Annex VI limit. The year that EPA considers most appropriate at this time is 2007. For both tiers of standards, we would define NO<sub>x</sub> standards as a function of maximum engine speed, consistent with Annex VI, but are requesting comment on the merits of defining Tier 2 NO<sub>x</sub> standards instead as a function of engine displacement. Both tiers of standards can be met through engine-based emission-control technologies. The Annex VI NO<sub>x</sub> limits are based on certification on distillate fuel, which has a lower nitrogen content than the residual fuel that these engines are most likely to use in operation. We are proposing numerical emission limits based on residual fuel, but allow for certification testing using distillate or residual fuel. In either case, we are proposing that the test results be adjusted to account for the nitrogen content of the fuel, and then be compared to the proposed emission limits. The fuel quality adjustment is described in Section IV.A.2, below.

In addition to the Tier 2 NO<sub>x</sub> limits, we are considering hydrocarbon and carbon monoxide emission limits at 0.4 g/kW-hr and 3.0 g/kW-hr, respectively. These standards would ensure that these emissions do not increase on an engine-specific basis. We are also considering adoption of a schedule to review any Tier 2 standards prior to their effective date to take into consideration continued development of new technologies, such as selective catalyst reduction and water-based emission reduction techniques, and international activity such as action at IMO to adopt more stringent standards internationally. We request comment on the hydrocarbon and carbon monoxide standards.

We are not planning to adopt a Tier 2 standard for particulate emissions from these engines. Most of the particulate emissions are a result of the high sulfur and ash content of the fuel used by these engines, and there is no acceptable measurement procedure for fuels with these characteristics. We are requesting comment, however, on whether we should consider a fuel sulfur content limit for the fuels used by these engines. One option, for example, would be to set a sulfur content cap equivalent to the limit for fuel used in SO<sub>x</sub> Emission Control Areas provided in Regulation 14 of MARPOL Annex VI. Pursuant to that regulation, the sulfur content of fuel used by vessels operating in those areas cannot exceed 15,000 ppm. The United States could also pursue this option through procedures contained in Regulation 14 of MARPOL Annex VI. That regulation provides for the designation of SO<sub>x</sub> emission control areas. We estimate that reducing the sulfur content of residual fuel to 15,000 ppm may decrease the PM inventory of these engines 18 percent and the SO<sub>x</sub> inventory by 44 percent (See Section VI.F, below). In connection with this option, we are seeking comment as to which areas of the United States should be considered for designation as SO<sub>x</sub> emission control areas under MARPOL Annex VI, and whether and how we should seek the cooperation of Canada, Mexico, and the Caribbean in designating these areas. Both of these options are discussed in Section VI.E, below.

We are also proposing voluntary low emission NO<sub>x</sub> standards for Category 3 marine diesel engines. These standards, which represent an 80 percent reduction from the Annex VI NO<sub>x</sub> limits, are intended to encourage the introduction and more widespread use of low-emission technologies. Manufacturers could be motivated to exceed emission requirements either to gain early experience with certain technologies or as a response to market demand or local government programs. Ship owners could take advantage of these and other emission reduction technologies to receive special recognition from EPA for installing and using technologies that reduce waste and air emissions under our proposed voluntary Blue Cruise program.

To implement these standards for marine diesel engines at or above 30 liters per cylinder in an effective way, we are proposing several compliance requirements. In general, the proposed compliance program reflects our traditional manufacturer-based approach. This is in contrast to the international approach reflected in Annex VI, which holds the vessel owner responsible for compliance once the engine is delivered onboard. Many of the proposed compliance provisions, including certification application, engine labeling, and warranty requirements, are similar or identical to the compliance provisions that we finalized in our 1999 rulemaking. In addition, we are including a post-installation verification provision which would require an emission test after an engine is installed on a vessel. We are also proposing a field measurement provision that would apply to engines with adjustable parameters or add-on emission control devices. Manufacturers of these engines would be required to equip the engine with a field measurement device. The owner of a vessel with such an engine would have to perform a field measurement when the vessel approaches within 175 nautical miles (200 statutory miles) of the U.S. coastline from the open sea or when it adjusts an engine parameter within that distance. The results of this field measurement will demonstrate that the engine is in compliance with the relevant standards when it is operated in an area that affects U.S. air quality. EPA will work with the U.S. Coast Guard to develop procedures to verify onboard performance of these field measurement provisions, as Coast Guard has the general authority to carry out such procedures on vessels.

We are also proposing new requirements for engines at or above 2.5 liters per cylinder but less than 30 liters per cylinder. The Tier 2 standards we finalized for these engines in our 1999 commercial marine diesel rule are effective in 2007. Until then, and pending entry into force of Annex VI, we encouraged engine manufacturers to voluntarily comply with Tier 1 standards, which are equivalent to the internationally negotiated NO<sub>x</sub> standards. Because Annex VI has not gone into force, they remain unenforceable. While the U.S. is beginning the ratification process for Annex VI, due to the continued uncertainty regarding its entry into force of Annex VI, we believe it is appropriate to begin to require engine manufacturers to certify these engines to the Tier 1 standards, starting in 2004. We are also proposing to eliminate the foreign trade exemption for all marine diesel engines, which was available for engines installed on vessels that spend less than 25 percent of total operating time with 320 kilometers of U.S. territory. To date, this exemption has not been requested by engine manufacturers.

The standards discussed above would apply to engines installed on vessels flagged in the United States. Recognizing that foreign-flag vessels constitute a significant portion of emissions from these engines and that the internationally negotiated NO<sub>x</sub> standards for these engines are not yet enforceable, we are seeking comment on whether the standards should also apply to

marine engines on foreign vessels entering U.S. ports and to no longer exclude such foreign vessels from the emission standards under 40 CFR 94.1(b)(3). If we were to apply our emission standards to foreign vessels that enter U.S. ports, then the standards would apply to any marine engine that is manufactured after the standards become effective and that is installed on such a foreign vessel. The standards would also apply to any marine engine installed on such a foreign vessel that is manufactured (or that otherwise become new) after the standards become effective. As discussed below, if the standards were to apply to foreign flag vessels, EPA would consider any significant differences between this proposed rule and Annex VI.

#### **D. Why Is EPA Taking This Action?**

We developed this emission control program to fulfill our obligations under Section 213 of the Clean Air Act. That section, described in more detail in Section E, below, requires us to set standards for new nonroad engines. In addition, there are important public health and welfare reasons supporting the standards proposed in this document. As described in Section II.B, Category 3 marine diesel engines contribute to air pollution which causes public health and welfare problems. Emissions from these engines contribute to ground level ozone and ambient PM and CO levels, especially in and near commercial ports and waterways.<sup>3</sup> Exposure to ground level ozone, PM, and CO can cause serious respiratory problems. These emissions also contribute to other environmental problems, including acid deposition, eutrophication, and nitrification.

This action is a departure from the emission control strategy we finalized in 1999 (64 FR 73300, December 29, 1999) in that we are considering no longer relying solely on MARPOL Annex VI for controlling emissions from Category 3 marine diesel engines. While the Annex VI NOx limits apply to engines installed on vessels constructed on or after January 1, 2000, those standards are not enforceable until the Annex enters into force. As specified in Article 6 of the Annex, it will enter into force twelve months after the date on which not less than fifteen member states, the combined merchant fleets of which constitute not less than 50 percent of the gross tonnage of the world's merchant shipping, have ratified the agreement. To date, more than four years after it was adopted, the Annex has been ratified by only 6 countries representing 15.8 percent of the world's merchant shipping.<sup>4</sup> In addition, the Annex VI NOx limits no longer reflect the greatest degree of emission control that can be achieved using newer technology, given appropriate lead time. Since we finalized our commercial marine diesel engine standards in 1999 (64 FR 73300, December 29, 1999), engine manufacturers continue to make progress in

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<sup>3</sup>Ground-level ozone, the main ingredient in smog, is formed by complex chemical reactions of volatile organic compounds (VOCs) and NOx in the presence of heat and sunlight. Hydrocarbons (HC) are a large subset of VOC, and to reduce mobile-source VOC levels we set maximum emissions limits for hydrocarbon and particulate matter emissions.

<sup>4</sup>The countries that have ratified Annex VI are Sweden, Norway, Bahamas, Singapore, Marshall Islands, and Malawi. Information about Annex VI ratification can be found at <http://www.imo.org> (look under Conventions, Status of Conventions - Complete List).

applying land-based emission control technologies to marine diesel engines. Improvements in fuel systems and engine cooling can reduce Category 3 engine emissions even more than the Annex VI NO<sub>x</sub> limits would require. Some engine manufacturers are also experimenting with water emulsification and injection and aftertreatment, including selective catalyst reduction, for even greater reductions. These emission control technologies are described in greater detail in Section IV.

## **E. Putting This Proposal Into Perspective**

This proposal should be considered in the broader context of EPA's nonroad emission-control programs, international activities, including MARPOL Annex VI, our previous marine emission control program, European Union (EU) initiatives, and activities at the state level. These programs and actions are discussed below.

### **1. EPA's nonroad emission-control programs**

Clean Air Act section 213(a)(1) directs us to study emissions from nonroad engines and vehicles to determine, among other things, whether these emissions "cause, or significantly contribute to, air pollution that may reasonably be anticipated to endanger public health or welfare." Section 213(a)(2) further requires us to determine whether emissions of CO, VOCs, and NO<sub>x</sub> from all nonroad engines significantly contribute to ozone or CO emissions in more than one nonattainment area. If we determine that emissions from all nonroad engines are significant contributors, section 213(a)(3) then requires us to establish emission standards for classes or categories of new nonroad engines and vehicles that in our judgment cause or contribute to such pollution. We may also set emission standards under section 213(a)(4) regulating any other emissions from nonroad engines that we find contribute significantly to air pollution.

We completed the Nonroad Engine and Vehicle Emission Study, required by Clean Air Act section 213(a)(1), in November 1991.<sup>5</sup> On June 17, 1994, we made an affirmative determination under section 213(a)(2) that nonroad emissions are significant contributors to ozone or CO in more than one nonattainment area. We also determined that these engines make a significant contribution to PM and smoke emissions that may reasonably be anticipated to endanger public health or welfare. In the same document, we set a first phase of emission standards (now referred to as Tier 1 standards) for land-based nonroad diesel engines rated at or above 37 kW. In 1998, we set more stringent Tier 2 and Tier 3 emission levels for new land-based nonroad diesel engines at or above 37 kW and adopted Tier 1 standards for nonroad diesel engines, including marine diesel engines, less than 37 kW. Our other emission-control programs for nonroad engines are listed in Table I.E-1. This proposal takes another step toward the comprehensive nonroad engine emission-control strategy envisioned in the Act by proposing enforceable emission limits for marine diesel engines at or above 30 liters per cylinder.

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<sup>5</sup>This study, the Nonroad Engine and Vehicle Emission Study (NEVES) is available in docket A-92-28.

Table I.E-1  
EPA's Nonroad Emission-Control Programs

Engine Category	Final Rulemaking	Date
Land-based diesel engines $\geq$ 37 kW —Tier 1	56 FR 31306	June 17, 1994
Spark-ignition engines $\leq$ 19 kW —Phase 1	60 FR 34581	July 3, 1995
Spark-ignition marine	61 FR 52088	October 4, 1996
Locomotives	63 FR 18978	April 16, 1998
Land-based diesel engines - Tier 1 and Tier 2 for engines $<$ 37 kW (these standards also apply to marine diesel engines $<$ 37 kW) - Tier 2 and Tier 3 for engines $\geq$ 37 kW	63 FR 56968	October 23, 1998
Commercial marine diesel engines above 37 kW (Standards apply to engines less than 30 liters per cylinder only)	64 FR 73300	December 29, 1999
Spark-ignition engines $\leq$ 19 kW (Non-handheld) —Phase 2	64 FR 15208	March 30, 1999
Spark-ignition engines $\leq$ 19 kW (Handheld) —Phase 2	65 FR 24268	April 25, 2000
Nonroad large spark-ignition engines, recreational vehicles, and recreational marine diesel engines	66 FR 51098 (proposal)	October 5, 2001
Marine evap. (includes highway motorcycles)	Expected 2002	

## 2. MARPOL Annex VI

In response to growing international concern about air pollution and in recognition of the highly international nature of maritime transportation, the IMO developed a program to reduce NO<sub>x</sub> and SO<sub>x</sub> emissions from marine vessels.<sup>6, 7</sup> The development of Annex VI took place between 1992 and 1997. The Annex VI engine emission limits cover only NO<sub>x</sub> emissions; there are no restrictions on PM, HC, or CO emissions. They are based on engine speed and apply to engines above 130 kW. These standards are set out in Table I.E-2. Originally, these standards were expected to reduce NO<sub>x</sub> emissions by 30 percent when fully phased in. EPA inventory analysis, based on newly estimated emission factors for these engines, indicates that the expected reduction is on the order of about 20 percent. The EPA inventory analysis is described in more detail in the Draft Regulatory Support Document for this proposal.

With regard to implementation, the Annex VI NO<sub>x</sub> limits apply to each diesel engine with a power output of more than 130 kW installed on a ship constructed on or after January 1, 2000, or

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<sup>6</sup>The Annex covers a several air emissions from marine vessels: ozone depleting substances, NO<sub>x</sub>, SO<sub>x</sub>, VOCs from tanker operations, incineration, fuel oil quality. There are also requirements for reception facilities and platforms and drilling rigs.

<sup>7</sup>To obtain copies of this document, see Footnote 1, above.

that undergoes a major conversion on or after January 1, 2000. The Annex does not distinguish between marine diesel engines installed on recreational or commercial vessels; all marine diesel engines above 130 kW would be subject to the standards regardless of their use. The test procedures to be used to demonstrate compliance are set out in the Annex VI NO<sub>x</sub> Technical Code<sup>8</sup>. They are based on ISO 8178 and are performed using distillate fuel. Engines can be pre-certified or certified after they are installed onboard. After demonstrating compliance, pre-certified engines would receive an Engine International Air Pollution Prevention (EIAPP) certificate. This document, to be issued by the Administration of the flag country, is needed by the ship owner as part of the process of demonstrating compliance with all of the provisions of Annex VI and obtaining an International Air Pollution Prevention (IAPP) certificate for the vessel once the Annex goes into force. The Annex also contains engine compliance provisions based on a survey approach. These survey requirements would apply after the Annex goes into force. An engine is surveyed after it is installed, every five years after installation, and at least once between 5-year surveys. Engines are not required to be tested as part of a survey, however. The surveys can be done by a parameter check, which can be as simple as reviewing the Record Book of Engine Parameters that must be maintained for each engine and verifying that current engine settings are within allowable limits.

After several years of negotiation, the Parties to MARPOL adopted a final version of Annex VI at a Diplomatic Conference on September 26, 1997. However, as noted in Section I.C, above, the Annex has not yet gone into force. Pending entry into force, ship owners and vessel manufacturers have begun installing compliant engines on relevant ships beginning with the date specified in Regulation 13: January 1, 2000. In addition, ship owners must bring existing engines into compliance if the engines undergo a major conversion on or after that date.<sup>9</sup> As defined in Regulation 13 of Annex VI, a major conversion is when the engine is replaced by a new engine, it is substantially modified, or its maximum continuous rating is increased by more than 10 percent. To facilitate implementation while the Annex is not yet in force and to allow engine manufacturers to certify their engines before the Annex goes into force, we set up a process for manufacturers to obtain a Statement of Voluntary Compliance.<sup>10</sup> An EPA-issued Statement of Voluntary Compliance should be exchangeable for an EIAPP certificate once the Annex goes into effect in the United States.

The U.S. government is preparing the appropriate documents for the President to submit Annex VI to the Senate for its advice and consent to ratification. Besides setting standards for

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<sup>8</sup>To obtain copies of this document, see Footnote 1, above.

<sup>9</sup>As defined in Regulation 13 of Annex VI, a major conversion means the engine is replaced by a new engine, it is substantially modified, or its maximum continuous rating is increased by more than 10 percent.

<sup>10</sup>For more information about our voluntary certification program, see “guidance for Certifying to MARPOL Annex VI,” VPCD-99-02. This letter is available on our website: <http://www.epa.gov/otaq/regs/nonroad/marine/ci/imoletttr.pdf> and in Docket A-2001-11, Document No. II-B-01.



NOx emissions, Annex VI regulates ozone-depleting emissions, sulfur oxides emissions and shipboard incineration, and contains other environmentally protective measures. In transmitting Annex VI to the Senate, the Administration will work with Congress on new legislation to implement the Annex. At the same time, the United States government supports a revision of the Annex VI standards for NOx emissions, taking into account the emission reduction potential of new control technologies. By ratifying the Annex, the United States will continue its leadership in promoting environmentally responsible international emission standards at the IMO and recognize the role the IMO plays in protecting the world's marine environment from pollution. As described in Section I.E.4, below, we have already requested MEPC to begin consideration of more stringent NOx emission limits for marine diesel engines. In addition, once the Annex goes into force, amendment of NOx standards will be made easier through the tacit amendment process that would then apply.

### 3. EPA's Commercial Marine Diesel Engine Rules

Although we included marine diesel engines in the development of our 1996 marine rule, we did not finalize standards for these engines at that time. At the time, we were considering standards based on Tier 1 land-based nonroad diesel emission controls. Emerging emission control technologies for diesel engines, particularly the Tier 2 land-based nonroad emission control technologies, led us to reconsider our approach and to defer standards for these engines to a later rulemaking.

In our 1999 commercial marine diesel engine rule, we distinguished between different types of marine diesel engines. The three categories of marine diesel engines, contained in Table I.E-3, were intended to reflect differences in the land-based counterparts of these engines.

Table I.E-3  
Marine Engine Category Definitions

Category	Displacement per cylinder	Land-Based Equivalent
1	disp. < 5 liters (and power $\geq$ 37 kW)	Agricultural equipment; construction equipment
2	5 liters $\leq$ disp. < 30 liters	Locomotives
3	disp $\geq$ 30 liters	No mobile source equivalent Power plant generators

The final standards for Category 1 and Category 2 marine diesel standards were more stringent than the Annex VI NOx limits, reflecting the greater degree of emission control that would be achievable through the application of technologies that would be used on the land-based equivalents of these engines to meet the nonroad Tier 2 and locomotive Tier 1 standards. The standards also cover more pollutants than Annex VI, including standards for HC, CO, and PM as well as NOx. The emission standards we finalized for Category 1 and Category 2 marine

diesel engines are similar to the nonroad Tier 2 and locomotive Tier 1 standards, respectively.

We did not finalize standards for Category 3 marine diesel engines in 1999. Instead, we deferred to the Annex VI NO<sub>x</sub> emission control program. This decision was based on our technological analysis of control strategies for these engines which indicated that the appropriate standards should reflect reductions that can be obtained from injection rate shaping and some timing retard. These control technologies were consistent with the Annex VI NO<sub>x</sub> limits. While some Category 3 engines were already using Tier 2 engine technologies including turbocharging, injection improvements, electronics, and more efficient cooling, these technologies were being used to increase fuel efficiency and obtain optimal operation. Next-generation technologies such as exhaust gas recirculation (EGR), selective catalyst reduction (SCR), and water injection were still under development for marine diesel engines of that size. Because the Annex VI NO<sub>x</sub> limits would likely be implemented independently of any Clean Air Act requirement, EPA believed that it would be unnecessary and redundant to adopt the same program under the Clean Air Act. Vessel owners were anticipated to begin complying with the Annex VI NO<sub>x</sub> limits beginning in 2000, as indicated in the Annex.

Since 1999, Category 3 marine diesel engine manufacturers have continued to research emission control technologies and explore ways to transfer land-based diesel engine technologies to marine diesel engines. These technologies and emission control strategies are described in Sections IV and VII below, and in the draft Regulatory Support Document for this rule. Due to these advances, and due to the contribution of these engines to ozone and PM levels, we believe it is now appropriate to consider a second tier of emission limits for Category 3 marine diesel engines that will achieve greater reductions than those expected from the Annex VI NO<sub>x</sub> limits.

#### 4. Continuing Action at the IMO

At the time the Annex VI NO<sub>x</sub> limits were adopted, several Member States expressed concern that the NO<sub>x</sub> limits would not result in the emissions reductions they were intended to achieve. Due to the efforts of these Member States, the Conference of the Parties adopted a resolution that provides for review of the emission limits with the aim of adopting more stringent limits taking into account the adverse effects of such emissions on the environment and any technological developments in marine engines. This review is to occur at a minimum of five-year intervals after entry into force of the Annex and, if appropriate, amend the NO<sub>x</sub> limits to reflect more stringent controls.

In March of 2000, the United States requested MEPC to begin consideration of more stringent emission limits for marine diesel engines.<sup>11</sup> EPA's analysis of emission control technology for our 1999 rulemaking indicated that more stringent standards are feasible for all Category 1 and Category 2 marine diesel engines. Engine manufacturers were also beginning to

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<sup>11</sup>MEPC 44/11/7, Prevention of Pollution from Ships, Revision of the NO<sub>x</sub> Technical Code, Tier 2 emission limits for marine diesel engines at or above 130 kW, submitted by the United States. This document is available at Docket A-2001-11, Document No. II-A-16.

apply these emission control strategies to Category 3 marine diesel engines, as well as more advanced strategies such as water emulsification and selective catalyst reduction. Reflecting the potential emission reductions that could be obtained from applying these strategies to all marine diesel engines, the U.S. recommended Annex VI Tier 2 NO<sub>x</sub> limits be set at 25 to 30 percent below the existing Annex VI NO<sub>x</sub> limits for all engines subject to the regulation (engines above 130 kW), to go into effect in 2007. This would allow a 7-year period of stability for the Annex VI NO<sub>x</sub> limits, permit engine manufacturers to adjust their engine designs to include new emission control technologies, and allow manufacturers of marine diesel engines at or above 30 liters per cylinder to develop emission control strategies for those large engines. This recommendation was briefly discussed at the 44<sup>th</sup> session of the MEPC (London, March 3-16, 2000), but was not acted on. The United States will continue to promote more stringent standards at IMO and encourage MEPC to adopt a second tier of emission limits that will reflect available technology and reduce the impact of marine diesel engines on the world's air quality.

## 5. European Union Actions

In February, 1999, the European Commission D-GXI commissioned a report to “consider, analyse and recommend policy options to further the objective of reducing the harmful environmental impact of SO<sub>x</sub> and NO<sub>x</sub> from ships operating in European waters.”<sup>12</sup> The final report was completed in August 2000. The report explores two types of regulatory options, regulatory standards and incentive plans, for both fuel and engine emission controls. The report is currently under consideration by the Commission.

In January 2001, the Directorate-General for the Environment issued a discussion paper entitled “A Community Strategy on Air Pollution from Seagoing Ships.”<sup>13</sup> This paper contains a description of issues and solicits comments that will be used to develop a European emission control strategy for marine vessels. The discussion paper envisions two products: a Commission Communication and a proposal to amend EU Directive 1999/32 on the Sulphur Content of Liquid Fuels.

The discussion paper notes that current inventory analysis indicates that ships will account for 75% and 60% of EU land SO<sub>x</sub> and NO<sub>x</sub> emissions, respectively. A new inventory study currently being commissioned will shed more light on these contributions, particularly in-port

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<sup>12</sup>Davies, M. E., et al., Study on the Economic, Legal, Environmental and Practical Implications of a European Union System to Reduce Ship Emissions of SO<sub>2</sub> and NO<sub>x</sub>, Final Report for European Commission Contract B4-3040/98/000839/MAR/B1, August 2000. This report is available at <http://www.europa.eu.int/comm/environment/air/transport.htm#3>. A copy can also be found in Docket A-2001-11, Document No. II-A-17.

<sup>13</sup>This discussion paper can be found at [http://www.europa.eu.int/comm/environment/air/future\\_transport.htm](http://www.europa.eu.int/comm/environment/air/future_transport.htm) (Under “pollutant emissions from ships” then “new developments”). A copy of this paper can also be found in Docket A-2001-11, Document No. II-A-28.

contributions. The discussion paper also describes current EU and international regulatory regimes and the potential for further reductions. Regarding SOx emissions, EU Directive 1999/32 currently prohibits the use of marine distillate fuels having more than 2,000 ppm sulfur in Community territorial waters. While there is an exemption for ships coming from third countries, those ships must use low sulfur distillate after they make their first stop at a Community port. There is some concern that this approach encourages ships to burn heavy fuel while in Community waters. Regarding NOx emissions, the paper describes the MARPOL Annex VI requirements, the EPA standards established in 1999, and the U.S. action to encourage IMO to consider more stringent NOx limits. The paper does not suggest potential emission control programs for the EU, but it requests comment support for more stringent standards.

## 6. Action By Individual European Countries

In 1996 the Swedish Maritime Administration, the Swedish Shipowners' Association and the Swedish Ports' and Stevedores' Association arrived at a Tripartite Agreement to decrease ship nitrogen oxides and sulphur emissions by 75% within five years. The parties agreed to establish an environmental program on differentiated fairway and port dues for NOx levels and fuel sulphur content. The program was constructed by first raising the ship related dues (from Swedish Kroner (SEK) 3.90 per gross tonne (GT) for oil tankers and SEK 3.60 per GT for ferries and other ships to SEK 5.30 and SEK 5.00 respectively) from which the discounts would be subtracted<sup>14</sup>. For use of low sulphur fuels a credit of SEK 0.90 per GT was given for ships operating on bunker oils of a sulphur content of less than 0.5 per cent by weight for ferries and less than 1.0 per cent for other ships. For low NOx emissions, if the emission at 75 per cent engine load is above 12 g/kWh, no NOx discount is given. Below this level the discount increases continuously down to a level of 2 g/kWh where the discount is SEK 1.60 per GT. A maximum discount of SEK 2.50 per GT is possible. The program entered into force January 1, 1998 and as of 1999, twenty of Sweden's fifty two ports have introduced environmentally differentiated harbour dues for reduced sulphur fuels, reduced NOx emissions or both. Ferries are using new technologies, including water emulsion systems (20-50% Nox reduction) and SCR systems (up to 95% NOx reduction), to achieve the low emission levels. To overcome initial problems and encourage the installation of catalytic converters, the Swedish Maritime Administration agreed to reimburse shipowners for the fairway dues paid during the first five years of the program (thru 2002). "Based on known planned installations, the National Maritime Administration expects that by 1 January 2001 the scheme will have reduced NOx emissions from ships calling at Swedish ports by 40-45 per cent compared to the situation in 1995."<sup>15</sup>

Over the past three years several other localities worldwide have also incorporated adjustments in port dues based on compliance with emission levels. The Port of Mariehamn, on the Finnish Island of Aland differentiates its harbor dues with regard to ships' emissions of NOx

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<sup>14</sup>One Swedish Kroner (SEK) is about \$0.09

<sup>15</sup>A further detailed discussion of this topic can be found at <http://www.sjofartsverket.se/navigering/htm/frameset.htm>.

and sulphur. The proposal in 1999 was to “give ships emitting less than 10 g/kWh NO<sub>x</sub> a rebate on a linear scale where the reduction of the port due is 8 per cent for ships emitting less than 1 gramme, and 1 per cent for ships emitting 9 g/kWh. Ships using bunker oils with less than 0.5 per cent sulphur (by weight) will receive an additional reduction of 4 per cent. For vessels meeting the latter criteria and having NO<sub>x</sub> emissions of less than 1 g/kWh the proposal is to offer an extra rebate of 8 per cent. Such ships will, if the scheme is adopted, get a total reduction of 20 per cent.”<sup>16</sup> The Norwegian government has a program for environmental differentiation of the tonnage tax (Proposition NO 1 1999/2000). The differentiation is based on a Ship Environment Index System (SEIS). The SEIS is based on up to seven different environmental parameters, including sulphur and NO<sub>x</sub> emissions with a maximum of 10 points of which 6 points are from the abatement of NO<sub>x</sub> and sulphur emissions. The program will raise the tonnage tax by 50 per cent and ships registered according to the environmental index system will receive rebates in proportion to their environmental score. Ships that earn 10 points will not pay more than they did before the new scheme began operating and ships that do not register or do not earn any points will have to pay the full tax.”<sup>17</sup> The Green Award Foundation, with the Port of Rotterdam and some ports in Portugal and South Africa offers reduced harbor dues for tankers of more than 20,000 DWT. To earn the award, the shipowner and the vessel must comply with national and international laws and regulations as well as demonstrate environmental and safety awareness in a number of areas affecting management and crew competence as well as technical provisions which includes exhaust emissions.

## 7. State Actions: SCAQMD, Alaska and Texas Smoke Requirements

Several states have programs that address smoke emissions from marine engines. This section summarizes the programs in SCAQMD, Alaska and Texas.

SCAQMD: California’s South Coast Air Quality Management District’s Rule 401 states “(b)(1)A person shall not discharge into the atmosphere from any single source of emission whatsoever any air contaminant for a period or periods aggregating more than three minutes in any one hour which is: (A) As dark or darker in shade as that designated No. 1 on the Ringelmann Chart as published by the United States Bureau of Mines; or (B) Of such opacity as to obscure an observer’s view to a degree equal to or greater than does smoke described in subparagraph (b)(1)(A) of this rule.”<sup>18</sup> The Port of Long Beach has issued literature requiring compliance with the SCAQMD rules through their Smoke Stack Emissions Program.<sup>19</sup>

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<sup>16</sup>A further detailed discussion of this topic can be found at <http://www.sjofartsverket.se/navigering/htm/frameset.htm>.

<sup>17</sup>A further detailed discussion of this topic can be found at <http://www.sjofartsverket.se/navigering/htm/frameset.htm>.

<sup>18</sup>A further detailed discussion of this topic can be found at <http://www.aqmd.gov/rules/html/r401.html>.

<sup>19</sup>A further detailed discussion of this topic can be found at <http://www.polb.com>.

The Port of Long Beach and the Port of Los Angeles also require, as of May 1, 2001, a Voluntary Commercial Cargo Ship Speed Reduction Program. The “Air Quality Compliance Zone” is with a 12 knot speed restriction beginning 20-nautical miles from Point Fermin to the boundaries of the existing mandatory Precautionary Area. The purpose is to reduce air pollution from ships in the South Coast Air Basin.<sup>20</sup>

ALASKA: Under Alaska’s present state law, with some exceptions, “ships must keep emissions from reducing visibility through the exhaust plume by more than 20% while in Alaska waters. Diesel exhausts and other smoky discharges from ships can create a haze that hangs over coastal communities. DEC receives regular complaints from coastal community residents about these emissions. The state has certified readers who observe the emissions coming from a cruise ship’s smokestack to determine if the standards are being exceeded.”<sup>21</sup>

TEXAS: The Texas Natural Resource Conservation Commission Chapter 111 of the document on Control of Air Pollution From Visible Emissions and Particulate Matter contains requirements of visible emissions from ships. The document, section 111.111(a)(6)(A) and (B), state that “(A)Visible emissions shall not be permitted from any railroad locomotive, ship or any other vessel to exceed an opacity of 30% for any five-minute period, except during reasonable periods of engine start-up. (B)Compliance with subparagraph(A) of this paragraph shall be determined by applying the following test methods, as appropriate:(i) Test Method 9,(40 CFR 60, Appendix A), or (ii) equivalent test method approved by the executive director and EPA.” This document was effective June 11, 2000.<sup>22</sup>

## **II. The Air Quality Need**

### **A. Overview**

This proposal contains a regulatory strategy for Category 3 marine diesel engines on U.S. vessels. Marine diesel engines at or above 30 liters per cylinder are very large marine engines used primarily for propulsion power on ocean-going vessels such as container ships, tankers, bulk carriers, and cruise ships. The vessels that use these engines are flagged in the United States and in other countries. Category 3 engines have not been regulated under our nonroad engine programs. Nationwide, these engines are a significant source of mobile source air pollution. As described in Section II.C, below, emissions from all Category 3 marine diesel engines, regardless of flag of registry, currently account for about 1.5 percent of national mobile source NO<sub>x</sub>, and 2.6 percent of national mobile source PM inventories.

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<sup>20</sup>A further detailed discussion of this topic can be found at <http://www.polb.com/NavAlert.htm>.

<sup>21</sup>A further detailed discussion of this topic can be found at [http://www.state.ak.us/local/akpages/ENV.CONSERV/press/2001/rel\\_1115.htm](http://www.state.ak.us/local/akpages/ENV.CONSERV/press/2001/rel_1115.htm).

<sup>22</sup>A further detailed discussion of this topic can be found at <http://www.tnrcc.state.tx.us/oprd/rules/pdflib/111a.pdf>

We conducted a study of emissions from nonroad engines, vehicles, and equipment in 1991, as directed by the Clean Air Act, section 213(a) (42 U.S.C. 7547(a)). Based on the results of that study, we determined that emissions of NO<sub>x</sub>, VOCs (including HC), and CO from nonroad engines and equipment contribute significantly to ozone and CO concentrations in more than one nonattainment area (see 59 FR 31306, June 17, 1994). Given this determination, section 213(a)(3) of the Act requires us to establish (and from time to time revise) emission standards for those classes or categories of new nonroad engines, vehicles, and equipment that in our judgment cause or contribute to such air pollution. We have determined that commercial marine diesel engines cause or contribute to such air pollution (see also the proposed commercial marine diesel engine preamble at 63 FR 68508, December 11, 1998 and the final rule at 64 FR 73300, December 29, 1999).

Where we determine that other emissions from new nonroad engines, vehicles, or equipment significantly contribute to air pollution that may reasonably be anticipated to endanger public health or welfare, section 213(a)(4) authorizes EPA to establish (and from time to time revise) emission standards from those classes or categories of new nonroad engines, vehicles, and equipment that cause or contribute to such air pollution. We have determined that commercial marine diesel engines cause or contribute to such air pollution (see also the proposed commercial marine diesel engine preamble at 63 FR 68508, December 11, 1998 and the final rule at 64 FR 73300, December 29, 1999).

#### **B. What are the Public Health and Welfare Concerns Associated with Emissions from Category 3 Diesel Marine Engines Subject to the Proposed Standards?**

The engines that would be subject to the proposed standards generate emissions of NO<sub>x</sub>, HC, PM and CO that contribute to ozone and CO nonattainment as well as adverse health effects associated with ambient concentrations of PM. This section contains a summary of the general health effects of these substances. Further information can be found in Chapter 2 of the Draft Regulatory Support Document. National and selected port city inventories are set out in Section II.C, and estimates of the expected impact of the proposed control program are described in Section VI.

##### **1. Ozone and its precursors**

Volatile organic compounds (VOC) and NO<sub>x</sub> are precursors in the photochemical reaction which forms tropospheric ozone. Ground-level ozone, the main ingredient in smog, is formed by complex chemical reactions of VOCs and NO<sub>x</sub> in the presence of heat and sunlight. Hydrocarbons (HC) are a large subset of VOC, and to reduce mobile-source VOC levels we set maximum emissions limits for hydrocarbon and particulate matter emissions.

A large body of evidence shows that ozone can cause harmful respiratory effects including chest pain, coughing, and shortness of breath, which affect people with compromised respiratory systems most severely. When inhaled, ozone can cause acute respiratory problems; aggravate asthma; cause significant temporary decreases in lung function of 15 to over 20 percent in some healthy adults; cause inflammation of lung tissue; produce changes in lung tissue and structure;

may increase hospital admissions and emergency room visits; and impair the body's immune system defenses, making people more susceptible to respiratory illnesses. Children and outdoor workers are likely to be exposed to elevated ambient levels of ozone during exercise and, therefore, are at a greater risk of experiencing adverse health effects. Beyond its human health effects, ozone has been shown to injure plants, which has the effect of reducing crop yields and reducing productivity in forest ecosystems.

There is strong and convincing evidence that exposure to ozone is associated with exacerbation of asthma-related symptoms. Increases in ozone concentrations in the air have been associated with increases in hospitalization for respiratory causes for individuals with asthma, worsening of symptoms, decrements in lung function, and increased medication use, and chronic exposure may cause permanent lung damage. The risk of suffering these effects is particularly high for children and for people with compromised respiratory systems.

Ground level ozone today remains a pervasive pollution problem in the United States. In 1999, 90.8 million people (1990 census) lived in 31 areas designated nonattainment under the 1-hour ozone NAAQS.<sup>23</sup> This sharp decline from the 101 nonattainment areas originally identified under the Clean Air Act Amendments of 1990 demonstrates the effectiveness of the last decade's worth of emission-control programs. However, elevated ozone concentrations remain a serious public health concern throughout the nation.

Over the last decade, declines in ozone levels were found mostly in urban areas, where emissions are heavily influenced by controls on mobile sources and their fuels. Twenty-three metropolitan areas have realized a decline in ozone levels since 1989, but at the same time ozone levels in 11 metropolitan areas with 7 million people have increased.<sup>24</sup> Regionally, California and the Northeast have recorded significant reductions in peak ozone levels, while four other regions (the Mid-Atlantic, the Southeast, the Central and Pacific Northwest) have seen ozone levels increase. The highest ambient concentrations are currently found in suburban areas, consistent with downwind transport of emissions from urban centers. Concentrations in rural areas have risen to the levels previously found only in cities.

To estimate future ozone levels, we refer to the modeling performed in conjunction with the

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<sup>23</sup>National Air Quality and Emissions Trends Report, 1999, EPA, 2001, at Table A-19. This document is available at <http://www.epa.gov/oar/aqtrnd99/>. The data from the Trends report are the most recent EPA air quality data that have been quality assured. A copy of this table can also be found in Docket No. A-2001-11, Document No. II-A-XX.

<sup>24</sup>National Air Quality and Emissions Trends Report, 1998, March, 2000, at 28. This document is available at <http://www.epa.gov/oar/aqtrnd98/>. Relevant pages of this report can be found in Memorandum to Air Docket A-2000-01 from Jean Marie Revelt, September 5, 2001. This memorandum is available in Air Docket A-2001-11, Document No. II-A-XX.



final rule for our most recent heavy-duty highway engine and fuel standards.<sup>25</sup> We performed ozone air quality modeling for the entire Eastern U.S. covering metropolitan areas from Texas to the Northeast.<sup>26</sup> This ozone air quality model was based upon the same modeling system as was used in the Tier 2 air quality analysis, with the addition of updated inventory estimates for 2007 and 2030. The results of this modeling were examined for those 37 areas in the East for which EPA's modeling predicted exceedences in 2007, 2020, and/or 2030 and the current 1-hour design values are above the standard or within 10 percent of the standard. This photochemical ozone modeling for 2020 predicts exceedences of the 1-hour ozone standard in 32 areas with a total of 89 million people (1999 census) after accounting for light- and heavy-duty on-highway control programs.<sup>27</sup> We expect the NOx control strategy contained in this Notice for Category 3 marine engines will further assist state efforts already underway to attain and maintain the 1-hour ozone standard.

In addition to the health effects described above, there exists a large body of scientific literature that shows that harmful effects can occur from sustained levels of ozone exposure much lower than 0.125 ppm.<sup>28</sup> Studies of prolonged exposures, those lasting about 7 hours, show health effects from prolonged and repeated exposures at moderate levels of exertion to ozone concentrations as low as 0.08 ppm. The health effects at these levels of exposure include transient pulmonary function responses, transient respiratory symptoms, effects on exercise performance, increased airway responsiveness, increased susceptibility to respiratory infection, increased hospital and emergency room visits, and transient pulmonary respiratory inflammation.

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<sup>25</sup>Additional information about this modeling can be found in our Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, document EPA420-R-00-026, December 2000. Docket No. A-2001-11, Document No. II-A-XX. This document is also available at <http://www.epa.gov/otaq/diesel.htm#documents>.

<sup>26</sup>We also performed ozone air quality modeling for the western United States but, as described further in the air quality technical support document, model predictions were well below corresponding ambient concentrations for our heavy-duty engine standards and fuel sulfur control rulemaking. Because of poor model performance for this region of the country, the results of the Western ozone modeling were not relied on for that rule.

<sup>27</sup>Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, US EPA, EPA420-R-00-026, December 2000, at II-14, Table II.A-2. Docket No. A-2001-11, Document Number II-A-XX. This document is also available at <http://www.epa.gov/otaq/diesel.htm#documents>.

<sup>28</sup>Additional information about these studies can be found in Chapter 2 of "Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements," December 2000, EPA420-R-00-026. Docket No. A-2001-11, Document Number II-A-XX. This document is also available at <http://www.epa.gov/otaq/diesel.htm#documents>.

Prolonged and repeated ozone concentrations at these levels are common in areas throughout the country, and are found both in areas that are exceeding, and areas that are not exceeding, the 1-hour ozone standard. Areas with these high concentrations are more widespread than those in nonattainment for that 1-hour ozone standard. Monitoring data indicate that 333 counties in 33 states exceed these levels in 1997-99.<sup>29</sup> The Agency's recent photochemical ozone modeling forecast that 111 million people are predicted to live in areas that are at risk of exceeding these moderate ozone levels for prolonged periods of time in 2020 after accounting for expected inventory reductions due to controls on light- and heavy-duty on-highway vehicles.<sup>30</sup>

## 2. Particulate Matter

Category 3 marine engines that would be subject to the proposed standards contribute to ambient particulate matter (PM) levels in two ways. First, they contribute through direct emissions of particulate matter. Second, they contribute to indirect formation of PM through their emissions of organic carbon, especially HC. Organic carbon accounts for between 27 and 36 percent of fine particle mass depending on the area of the country.

Particulate matter represents a broad class of chemically and physically diverse substances. It can be principally characterized as discrete particles that exist in the condensed (liquid or solid) phase spanning several orders of magnitude in size. All particles equal to and less than 10 microns are called PM<sub>10</sub>. Fine particles can be generally defined as those particles with an aerodynamic diameter of 2.5 microns or less (also known as PM<sub>2.5</sub>), and coarse fraction particles are those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns.

Particulate matter, like ozone, has been linked to a range of serious respiratory health problems. Scientific studies suggest a likely causal role of ambient particulate matter (which is attributable to several sources including mobile sources) in contributing to a series of health effects.<sup>31</sup> The key health effects categories associated with ambient particulate matter include premature mortality, aggravation of respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits, school absences, work loss days, and

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<sup>29</sup>A copy of these data can be found in Air Docket A-2001-11, Document No. II-A-XX.

<sup>30</sup> Memorandum to Docket A-99-06 from Eric Ginsburg, EPA, "Summary of Model-Adjusted Ambient Concentrations for Certain Levels of Ground-Level Ozone over Prolonged Periods," November 22, 2000, at Table C, Control Scenario – 2020 Populations in Eastern Metropolitan Counties with Predicted Daily 8-Hour Ozone greater than or equal to 0.080 ppm. Docket A-2001-11, Document Number II-B-XX.

<sup>31</sup>EPA (1996) Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information OAQPS Staff Paper. EPA-452/R-96-013. Docket Number A-99-06, Documents Nos. II-A-18, 19, 20, and 23. The particulate matter air quality criteria documents are also available at <http://www.epa.gov/ncea/partmatt.htm>.

restricted activity days), aggravated asthma, acute respiratory symptoms, including aggravated coughing and difficult or painful breathing, chronic bronchitis, and decreased lung function that can be experienced as shortness of breath. Observable human noncancer health effects associated with exposure to diesel PM include some of the same health effects reported for ambient PM such as respiratory symptoms (cough, labored breathing, chest tightness, wheezing), and chronic respiratory disease (cough, phlegm, chronic bronchitis and suggestive evidence for decreases in pulmonary function). Symptoms of immunological effects such as wheezing and increased allergenicity are also seen. Exposure to fine particles is closely associated with such health effects as premature mortality or hospital admissions for cardiopulmonary disease.

PM also causes adverse impacts to the environment. Fine PM is the major cause of reduced visibility in parts of the United States. Other environmental impacts occur when particles deposit onto soils, plants, water or materials. For example, particles containing nitrogen and sulphur that deposit on to land or water bodies may change the nutrient balance and acidity of those environments. Finally, PM causes soiling and erosion damage to materials, including culturally important objects such as carved monuments and statues. It promotes and accelerates the corrosion of metals, degrades paints, and deteriorates building materials such as concrete and limestone.

The NAAQS for PM<sub>10</sub> were established in 1987. According to these standards, the short term (24-hour) standard of 150  $\mu\text{g}/\text{m}^3$  is not to be exceeded more than once per year on average over three years. The long-term standard specifies an expected annual arithmetic mean not to exceed 50  $\mu\text{g}/\text{m}^3$  over three years. Recent PM<sub>10</sub> monitoring data indicate that 14 designated PM<sub>10</sub> nonattainment areas with a projected population of 23 million violated the PM<sub>10</sub> NAAQS in the period 1997-99. In addition, there are 25 unclassifiable areas that have recently recorded ambient concentrations of PM<sub>10</sub> above the PM<sub>10</sub> NAAQS.<sup>32</sup>

Current 1999 PM<sub>2.5</sub> monitored values, which cover about a third of the nation's counties, indicate that at least 40 million people live in areas where long-term ambient fine particulate matter levels are at or above 16  $\mu\text{g}/\text{m}^3$  (37 percent of the population in the areas with monitors).<sup>33</sup> This 16  $\mu\text{g}/\text{m}^3$  threshold is the low end of the range of long term average PM<sub>2.5</sub> concentrations in cities where statistically significant associations were found with serious health effects, including premature mortality.<sup>34</sup> To estimate the number of people who live in areas where long-term

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<sup>32</sup>EPA adopted a policy in 1996 that allows areas with PM<sub>10</sub> exceedances that are attributable to natural events to retain their designation as unclassifiable if the State is taking all reasonable measures to safeguard public health regardless of the sources of PM<sub>10</sub> emissions.

<sup>33</sup>Memorandum to Docket A-99-06 from Eric O. Ginsburg, Senior Program Advisor, "Summary of 1999 Ambient Concentrations of Fine Particulate Matter," November 15, 2000. Air Docket A-2001-11, Document No. II-B-XX.

<sup>34</sup>EPA (1996) Review of the National Ambient Air Quality Standards for Particulate Matter: Policy Assessment of Scientific and Technical Information OAQPS Staff Paper. EPA-452/R-96-013. Docket Number A-99-06, Documents Nos. II-A-18, 19, 20, and 23. The

ambient fine particulate matter levels are at or above  $16 \mu\text{g}/\text{m}^3$  but for which there are no monitors, we can use modeling. According to our national modeled predictions, there were a total of 76 million people (1996 population) living in areas with modeled annual average  $\text{PM}_{2.5}$  concentrations at or above  $16 \mu\text{g}/\text{m}^3$  (29 percent of the population).<sup>35</sup>

To estimate future  $\text{PM}_{2.5}$  levels, we refer to the modeling performed in conjunction with the final rule for our most recent heavy-duty highway engine and fuel standards, using EPA's Regulatory Model System for Aerosols and Deposition (REMSAD).<sup>36</sup> The most appropriate method of making these projections relies on the model to predict changes between current and future states. Thus, we have estimated future conditions only for the areas with current  $\text{PM}_{2.5}$  monitored data (which cover about a third of the nation's counties). For these counties, REMSAD predicts the current level of 37 percent of the population living in areas where fine PM levels are at or above  $16 \mu\text{g}/\text{m}^3$  to increase to 49 percent in 2030.<sup>37</sup>

### 3. Carbon Monoxide

Carbon monoxide (CO) is a colorless, odorless gas produced through the incomplete combustion of carbon-based fuels. Carbon monoxide enters the bloodstream through the lungs and reduces the delivery of oxygen to the body's organs and tissues. The health threat from CO is most serious for those who suffer from cardiovascular disease, particularly those with angina or peripheral vascular disease. Healthy individuals also are affected, but only at higher CO levels. Exposure to elevated CO levels is associated with impairment of visual perception, work capacity, manual dexterity, learning ability and performance of complex tasks.

High concentrations of CO generally occur in areas with elevated mobile-source emissions. Peak concentrations typically occur during the colder months of the year when mobile-source CO

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particulate matter air quality criteria documents are also available at <http://www.epa.gov/ncea/partmatt.htm>.

<sup>35</sup>Memorandum to Docket A-99-06 from Eric O. Ginsburg, Senior Program Advisor, "Summary of Absolute Modeled and Model-Adjusted Estimates of Fine Particulate Matter for Selected Years," December 6, 2000. Air Docket A-2001-11, Document No. II-B-XX.

<sup>36</sup>Additional information about the Regulatory Model System for Aerosols and Deposition (REMSAD) and our modeling protocols can be found in our Regulatory Impact Analysis: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements, document EPA420-R-00-026, December 2000. Docket No. A-2001-11, Document No. A-II-XX. This document is also available at <http://www.epa.gov/otaq/diesel.htm#documents>.

<sup>37</sup> Technical Memorandum, EPA Air Docket A-99-06, Eric O. Ginsburg, Senior Program Advisor, Emissions Monitoring and Analysis Division, OAQPS, Summary of Absolute Modeled and Model-Adjusted Estimates of Fine Particulate Matter for Selected Years, December 6, 2000, Table P-2. Docket Number 2001-11, Document Number II-B-XX.

emissions are greater and nighttime inversion conditions are more frequent. This is due to the enhanced stability in the atmospheric boundary layer, which inhibits vertical mixing of emissions from the surface.

The current primary NAAQS for CO are 35 parts per million for the one-hour average and 9 parts per million for the eight-hour average. These values are not to be exceeded more than once per year. Air quality carbon monoxide value is estimated using EPA guidance for calculating design values. In 1999, 30.5 million people (1990 census) lived in 17 areas designated nonattainment under the CO NAAQS.<sup>38</sup>

Nationally, significant progress has been made over the last decade to reduce CO emissions and ambient CO concentrations. Total CO emissions from all sources have decreased 16 percent from 1989 to 1998, and ambient CO concentrations decreased by 39 percent. During that time, while the mobile source CO contribution of the inventory remained steady at about 77 percent, the highway portion decreased from 62 percent of total CO emissions to 56 percent while the nonroad portion increased from 17 percent to 22 percent.<sup>39</sup> Over the next decade, we would expect there to be a minor decreasing trend from the highway segment due primarily to the more stringent standards for certain light-duty trucks (LDT2s).<sup>40</sup> CO standards for passenger cars and other light-duty trucks and heavy-duty vehicles did not change as a result of other recent rulemakings.

#### 4. Other Welfare and Environmental Effects

In addition to the health and welfare concerns just described, Category 3 marine diesel engines can contribute to regional haze, acid deposition, and eutrophication and nitrophication. Further information on these effects can be found in Chapter 2 of the Draft Regulatory Support Document.

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<sup>38</sup>National Air Quality and Emissions Trends Report, 1999, EPA, 2001, at Table A-19. This document is available at <http://www.epa.gov/oar/aqtrnd99/>. The data from the Trends report are the most recent EPA air quality data that have been quality assured. A copy of this table can also be found in Docket No. A-200111, Document No. II-A-XX.

<sup>39</sup> National Air Quality and Emissions Trends Report, 1998, March, 2000; this document is available at <http://www.epa.gov/oar/aqtrnd98/>. National Air Pollutant Emission Trends, 1900-1998 (EPA-454/R-00-002), March, 2000. These documents are available at Docket No. A-2000-01, Document No. II-A-72. See also Air Quality Criteria for Carbon Monoxide, US EPA, EPA 600/P-99/001F, June 2000, at 3-10. Air Docket A-2001-11, Document Number II-A-XX. This document is also available at <http://www.epa.gov/ncea/coabstract.htm>.

<sup>40</sup>LDT2s are light light-duty trucks greater than 3750 lbs. loaded vehicle weight, up through 6000 gross vehicle weight rating.

## **C. Contribution from Category 3 Marine Diesel Engines**

### **1. National Inventories**

We developed baseline Category 3 vessel emissions inventories under contract with E. H. Pechan & Associates, Inc.<sup>41</sup> Inventory estimates were developed separately for vessel traffic within 25 nautical miles of port areas and vessel traffic outside of port areas but within 175 nautical miles of the coastline. The inventories include all Category 3 traffic, including that on the Great Lakes. Different techniques were used to develop the port and non-port inventories. For port areas we developed detailed emissions estimates for nine specific ports using port activity data including port calls, vessel types and typical times in different operating modes. Emissions estimates for all other ports were developed by matching each of those ports to one of the nine specific ports already analyzed based on characteristics of port activity, such as predominant vessel types, harbor draft and region of the country. The detailed port emissions were then scaled to the other ports based on relative port activity. We developed non-port emissions inventories using cargo movements and waterways data, vessel speeds, average dead weight tonnage per ship, and assumed cargo capacity factors. More detailed information regarding the development of the baseline emissions inventories can be found in Chapter 6 of the Draft Regulatory Support Document.

There has been little study of the transport of marine vessel NO<sub>x</sub> emissions and the distance they may travel to impact air quality on land. Pollutant transport is a very complicated subject, and the transport distance can vary dramatically depending on a variety of factors, including the pollutant under consideration, as prevailing wind speed and direction, and other atmospheric conditions. When we consider how far off the coast to include emissions in our baseline the correct answer may well vary depending on geographic area and prevailing atmospheric conditions. Thus, in developing baseline emissions inventories we looked at two scenarios that we believe reasonably bracket the distances from shore that vessel emissions may be emitted and expected to impact air quality on land. First, we looked only at the pollutants emitted within 25 nautical miles of a port area as a reasonable lower bound to estimate the national inventory of Category 3 marine diesel engines. As an upper bound we considered all Category 3 emissions within 175 nautical miles of shore.

Not surprisingly, these two different distances yield different inventory results. The 1996 NO<sub>x</sub> and PM emissions inventories are shown in Table II.C-1. We used 1996 as the starting point for this analysis because that is the most recent year that we have detailed information available for the nine specific port areas. As will be discussed later in this section, this initial analysis shows that the contribution from U.S. and foreign flagged vessels differs between these two areas.

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<sup>41</sup> “Commercial Marine Emission Inventory Development,” E.H. Pechan and Associates, Inc. and ENVIRON International Corporation, April, 2002.

Table II.C-1

Category 3 Marine Diesel Engine 1996 Baseline Emissions Inventories (thousand short tons)

Scenario	NO <sub>x</sub>	PM
Within 25 nautical miles of ports	101	9.3
Within 175 nautical miles of coast	190	17

For the remainder of the analysis associated with the proposed emissions standards we will consider all emissions that occur within 175 nautical miles from the coast as our primary scenario. We request comment on all aspects of our emissions inventories. In particular, we request comment on whether we should consider a range different than 175 nautical miles from the coast as our primary scenario, and why. We also request comment on whether we should consider different distances from the coast for different areas of the country. For example, should we consider a smaller distance on the East coast than the West coast to account for prevailing wind patterns?

We will continue to investigate this issue throughout this rulemaking, and will incorporate any new information into the final rule. For example, the U.S. Department of Defense (DoD) has presented information to us recommending that a different, shorter (offshore distance) limit be established rather than the proposed 175 nautical miles as the appropriate location where emissions from marine vessels would affect on-shore air quality. DoD's extensive work on the marine vessels issue in Southern California resulted in a conclusion that emissions within 60 nautical miles of shore could make it back to the coast due to eddies and the nature of the sea breeze effects. Satellite data however showed a distinct tendency for a curved line of demarcation separating the offshore (unobstructed) or parallel ocean wind flow from a region of more turbulent, recirculated air which would impact on-shore areas. That curved line of demarcation was close to San Nicolas Island which is about 60 nautical miles offshore. Studies and published information on other coastal areas in California indicates that they experience somewhat narrower (perhaps 30 nautical miles) region of "coastal influence." The Gulf Coast and the U.S. East coast would similarly have their own unique meteorological conditions that might call for different lines of demarcation between on-shore and off-shore effects.

To estimate inventories for years after 1996, we developed inventory projections based on expected increases in vessel freight movement and expected changes in vessel characteristics, as well as fleet turnover based on 25 years as the average age of the world fleet at time of scrappage. We also take the MARPOL Annex VI NO<sub>x</sub> limits into account because, although these international NO<sub>x</sub> standards are not yet in force, we expect that most, if not all shipbuilders and shipping companies around the world are currently complying with them, and we expect this trend to continue. Our estimated emissions inventories are based on the assumption that all vessels built after 1999, both U.S. and foreign flagged, will comply with the MARPOL NO<sub>x</sub> limits. Table II.C-2 shows the future year NO<sub>x</sub> and PM inventories for selected years out to 2030. More detailed information regarding the development of the future year emissions inventories can be found in Chapter 6 of the Draft Regulatory Support Document. We request

comment on these inventory projections. In particular, we request comment on whether freight growth will continue at the exponential rate that has been seen in the past, and for how long such exponential growth can be expected to continue.

One very important consideration in projecting future year inventories is the make up and size of the future vessel fleet. The size and make up of the future U.S. flagged fleet is dependent on vessel construction at U.S. shipyards, the nature of vessel replacement practices, and any growth in the number of ships in the fleet. Projecting future vessel production at U.S. shipyards is difficult for two reasons. First, vessel construction totals for U.S. shipyards have varied quite a bit from year to year, with no clear trends. Second, the U.S. government discontinued subsidies to U.S. shipyards in 1983, creating a dramatic downward shift in production at U.S. shipyards. We request comment on likely future production at U.S. shipyards, including production estimates and the rationale behind the estimates. Vessel replacement practices also play a role in future year emissions inventory projections. For example, the current U.S. flagged fleet contains a large number of older steamships. We request comment on whether these steamships are likely to be replaced with diesels when they are scrapped. We also request comment on whether there are any other vessel replacement practices or trends that we should consider when projecting future year emissions inventories. As shown in Chapter 6 of the Draft Regulatory Support Document, a substantial portion of the U.S. flagged fleet is over 30 years old. We request comment on the size and nature of any increase in U.S. shipbuilding activity that may occur in the near future in an effort to replace the aging fleet. Finally, we request comment on whether the total number of U.S. flagged vessels is expected to grow substantially in the future and why.

Table II.C-2  
Future Year NO<sub>x</sub> and PM Inventories for Category 3 Marine Diesel Engines  
(thousand short tons)

Year	NO <sub>x</sub>			PM		
	Ports	Non-ports	All areas	Ports	Non-ports	All areas
1996	101	89	190	9	8	17
2010	146	128	274	14	12	26
2020	196	172	367	20	16	37
2030	288	243	531	30	24	54

Baseline emission inventory estimates for the year 2000 for Category 3 marine diesel engines are summarized in Table II.C-3 in the context of other emissions sources. This table shows the relative contributions of the different mobile-source categories to the overall national mobile-source inventory. Of the total emissions from mobile sources, all Category 3 marine diesel engines contributed about 1.5 percent of NO<sub>x</sub> and 2.6 percent of PM emissions in the year 2000.



Our draft emission projections for 2020 for Category 3 marine diesel engines show how emissions from these engines are expected to increase over time if left uncontrolled beyond the MARPOL Annex VI NO<sub>x</sub> limits. The projections for 2020 are summarized in Table II.C-4 and indicate that Category 3 marine diesel engines are expected to contribute 5.7 percent NO<sub>x</sub> and 5.8 percent of PM emissions in the year 2020. Population growth and the effects of other regulatory control programs are factored into these projections. The relative importance of uncontrolled nonroad engines is higher than the projections for 2000 because there are already emission control programs in place for the other categories of mobile sources which are expected to reduce their emission levels. The effectiveness of all control programs is offset by the anticipated growth in engine populations.

Table II.C-3  
Modeled Annual Emission Levels for  
Mobile-Source Categories in 2000 (thousand short tons)

Category	NOx		HC		CO		PM	
	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source
<b>Total for engines subject to proposed standards (U.S. flagged commercial marine - Category 3)</b>	<b>79</b>	<b>0.6%</b>	<b>2</b>	<b>0.0%</b>	<b>4</b>	<b>0.0%</b>	<b>7.0</b>	<b>1.0%</b>
Commercial Marine CI - Category 3	195	1.5%	8	0.1%	16	0.0%	18.0	2.6%
Commercial Marine CI - Categories 1 and 2	700	5.2%	22	0.3%	103	0.1%	20	2.9%
Highway Motorcycles	8	0.1%	84	1.1%	329	0.4%	0.4	0.1%
Nonroad Industrial SI > 19 kW	306	2.3%	247	3.2%	2,294	2.9%	1.6	0.2%
Recreational SI	13	0.1%	737	9.6%	2,572	3.3%	5.7	0.8%
Recreation Marine CI	24	0.2%	1	0.0%	4	0.0%	1	0.1%
Marine SI Evap	0	0.0%	89	1.2%	0	0.0%	0	0.0%
Marine SI Exhaust	32	0.2%	708	9.2%	2,144	2.7%	38	5.4%
Nonroad SI < 19 kW	106	0.8%	1,460	18.9%	18,359	23.5%	50	7.2%
Nonroad CI	2,625	19.6%	316	4.1%	1,217	1.6%	253	36.3%
Locomotive	1,192	8.9%	47	0.6%	119	0.2%	30	4.3%
Total Nonroad	5,201	39%	3,719	48%	27,157	35%	418	60%
Total Highway	7,981	60%	3,811	50%	49,811	64%	240	34%
Aircraft	178	1%	183	2%	1,017	1%	39	6%
Total Mobile Sources	13,360	100%	7,713	100%	77,985	100%	697	100%
Total Man-Made Sources	24,444	--	18,659	--	100,064	--	3,093	--
Mobile Source percent of Total Man-Made Sources	55%	--	41%	--	78%	--	23%	--

Table II.C-4  
Modeled Annual Emission Levels for  
Mobile-Source Categories in 2020 (thousand short tons)

Category	NOx		HC		CO		PM	
	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source	tons	percent of mobile source
<b>Total for engines subject to proposed standards (U.S. flagged commercial marine - Category 3)</b>	<b>150</b>	<b>2.3%</b>	<b>5</b>	<b>0.1%</b>	<b>9</b>	<b>0.0%</b>	<b>14.0</b>	<b>2.2%</b>
Commercial Marine CI - Category 3	367	5.7%	17	0.3%	37	0.0%	37.0	5.8%
Commercial Marine CI - Categories 1 and 2	617	9.6%	24	0.4%	125	0.1%	19.0	3.0%
Highway Motorcycles	14	0.2%	144	2.3%	569	0.6%	0.8	0.1%
Nonroad Industrial SI > 19 kW	486	7.6%	348	5.5%	2,991	3.3%	2.4	0.4%
Recreational SI	27	0.4%	1,706	27.1%	5,407	6.0%	7.5	1.2%
Recreation Marine CI	39	0.6%	1	0.0%	6	0.0%	1.5	0.2%
Marine SI Evap	0	0.0%	102	1.6%	0	0.0%	0	0.0%
Marine SI Exhaust	58	0.9%	284	4.5%	1,985	2.2%	28	4.4%
Nonroad SI < 19 kW	106	1.7%	986	15.6%	27,352	30.3%	77	12.0%
Nonroad CI	1,791	28.0%	142	2.3%	1,462	1.6%	261	40.6%
Locomotive	611	9.5%	35	0.6%	119	0.1%	21	3.3%
Total Nonroad	4,116	63%	3,789	60%	40,053	44%	455	70%
Total Highway	2,050	33%	2,278	36%	48,903	54%	145	23%
Aircraft	232	4%	238	4%	1,387	2%	43	7%
Total Mobile Sources	6,398	100%	6,305	100%	90,343	100%	643	100%
Total Man-Made Sources	16,374	--	16,405	--	114,011	--	3,027	--
Mobile Source percent of Total Man-Made Sources	39%	--	38%	--	79%	--	21%	--

## 2. Inventories for Specific Ports

In the previous section we presented estimates of Category 3 marine diesel engine emissions as percentages of the national mobile source inventory. Total national man-made source inventories were also included in Tables II.C-3 and II.C-4 for comparison. However, marine vessel activity tends to be concentrated in port areas, and thus we would expect that Category 3 marine diesel engines would have a proportionately bigger impact on the mobile source pollution inventories of port areas. Using the port-specific Category 3 inventories developed for use in our national inventory in conjunction with total port area inventories developed in support of the heavy-duty on-highway 2007 rule, we developed estimates of the contribution of Category 3 marine diesel engines to the mobile source NO<sub>x</sub> and PM inventories of several selected port areas, including several ozone nonattainment areas. The NO<sub>x</sub> results are shown in Table II.C-5, and the PM results are shown in Table II.C-6. As can be seen from these tables, the relative contribution of Category 3 marine diesel engine pollution to mobile source pollution is expected to increase in the future. This is due both to the expected growth of shipping traffic in the future and the effect of emissions control programs already in place for other mobile sources.

Table II.C-5  
Modeled NOx Inventories as a Percentage of Mobile Source NOx  
in Selected Port Areas

		% of Mobile Source NOx from C3	
Ozone Nonattainment Area?	Port Area	1996	2020
Y	Baton Rouge and New Orleans, LA	7.4	15.8
Y	Los Angeles/Long Beach, CA	2.0	8.6
Y	Beaumont/Port Arthur, TX	1.4	3.1
Y	Houston/Galveston/Brazoria, TX	1.5	4.9
Y	Baltimore/Washington DC	2.1	11.4
Y	Philadelphia/Wilmington/Atlantic City	1.8	6.9
Y	New York/New Jersey	1.0	6.2
N	Seattle/Tacoma/Bremerton/Bellingham, WA	4.3	26.3
N	Miami/Ft. Lauderdale, FL	5.4	28.1
N	Portland/Salem, OR	1.9	11.9
N	Wilmington, NC	6.9	26.8
N	Corpus Christi, TX	4.8	12.2
N	Brownsville/Harlington/San Benito, TX	1.8	6.6

Table II.C-6  
Modeled PM Inventories as a Percentage of Mobile Source PM  
in Selected Port Areas

Port Area	% of Mobile Source PM from C3	
	1996	2020
Baton Rouge and New Orleans, LA	12.1	22.6
Los Angeles/Long Beach, CA <sup>1</sup>	3.9	10.8
Beaumont/Port Arthur, TX	7.4	18.3
Houston/Galveston/Brazoria, TX	3.3	8.5
Baltimore/Washington DC	3.2	9.6
Philadelphia/Wilmington/Atlantic City	2.8	6.3
New York/New Jersey	1.6	5.7
Seattle/Tacoma/Bremerton/ Bellingham, WA	8.5	25.5
Miami/Ft. Lauderdale, FL	10.6	28.7
Portland/Salem, OR	3.9	12.1
Wilmington, NC	8.1	22.4
Corpus Christi, TX	6.0	9.6
Brownsville/Harlington/San Benito, TX	3.1	14.9

1. PM nonattainment area.

### 3. Emissions in Nonport Areas

These ships can also have a significant impact on inventories in areas without large commercial ports. For example, Santa Barbara estimates that engines on ocean-going marine vessels contribute about 37 percent of total NO<sub>x</sub> in their area. These emissions are from ships that transit the area, and “are comparable to (even slightly larger than) the amount of NO<sub>x</sub> produced onshore by cars and truck.”<sup>42</sup> These emissions are expected to increase to 62 percent by 2015. While Santa Barbara’s exact conditions may be unique due to the relative close proximity

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<sup>42</sup>Memorandum to Docket A-2001-11 from Jean Marie Revelt, “*Santa Barbara County Air Quality News*, Issue 62, July-August 2001 and other materials provided to EPA by Santa Barbara County,” March 14, 2002. Air Docket A-2001-11.

of heavily used shipping channels to shore and the meteorological conditions in their area, other coastal areas may also have relatively high inventory impacts from ocean-going vessels.

#### 4. Contribution by flag

It is important to determine how much of the Category 3 marine diesel engine pollution inventory is contributed by U.S. flagged vessels given that we are considering whether to restrict application of the proposed standards and standards under consideration to U.S. flag vessels only or to apply the standards to all vessels (U.S. and foreign-flag entering U.S. ports). We estimated the relative contribution of U.S. and foreign flagged vessels separately for the port areas and the non-port areas due to the fact that we had different data sets available to us for the two areas.

We estimated the contribution of U.S. flagged vessels for the ports areas using port call data obtained from the U.S. Maritime Administration (MARAD). These data contained all port calls in 1999 to U.S. ports by vessels of greater than 1000 gross registered tons, including the country in which they are flagged and the number of port calls each vessel made. An analysis of the port call data shows that U.S. flagged vessels only account for 6.4 percent of port calls to U.S. ports. For the lack of more detailed information regarding the breakout of U.S. and foreign flagged vessel emissions we applied the percentage of port calls from U.S. and foreign flagged vessels to the national ports inventories to determine the relative contributions of each to the national ports inventories.

We used freight tonnage data from the U.S. Army Corp of Engineers (USACE) to develop relative U.S. and foreign flagged emissions contributions in non-ports areas within 175 nautical miles of the coast. In contrast to the data for the ports areas, the USACE data suggests that more than 80 percent of the non-ports emissions come from U.S. flagged vessels.

The relative contributions from U.S. and foreign flagged vessels are quite different between the ports areas and the non-ports areas. Some of this difference can be explained through U.S. cabotage law, which requires that any vessel operating between two U.S. ports be U.S. flagged. Thus, while most port traffic is foreign flagged, the foreign flagged vessels would tend to come into a single U.S. port and then leave U.S. waters. In contrast, U.S. flagged vessels would typically travel from one U.S. port to another, thus accounting for a higher percentage of the non-ports emissions. We request comment on this assessment of U.S. and foreign flagged vessel contributions, as well as additional data that would help us further understand the relative contributions of U.S. and foreign flagged vessels to the national pollution inventories.

For the purposes of the future inventory projections we assumed that the current split of U.S. and foreign flagged emissions would continue. However, this assumption, in combination with our assumed growth rates, implies that the manufacture of Category 3 vessels in the U.S. for the U.S. flagged fleet would occur in the future at rates greater than the recent build rate of around two vessels per year. More likely, seven to nine new U.S. flagged vessels would need to be built per year to accommodate the U.S. flagged vessel emissions growth assumptions. We request comment on whether the U.S. flagged fleet is expected to grow at this rate in the future, or instead whether a growing fraction of vessel emissions would come from foreign flagged vessels

in the future. Specifically, we request comment on the likely replacement rates and expected new capacity of the U.S. fleet in the future.

### **III. What Engines Are Covered?**

The scope of application of this proposal is broadly set by Clean Air Act section 213(a)(3), which instructs us to set standards for new nonroad engines and new nonroad vehicles. In this case, the proposed rule is intended to cover all new marine diesel engines installed on vessels flagged or registered in the United States that have a specific engine displacement greater than or equal to 30 liters per cylinder. Under the requirements of the Clean Air Act, once emission standards apply to a group of engines, a manufacturer of a new engine must get a certificate of conformity from us before selling an engine, importing an engine, or otherwise introducing an engine into commerce in the United States.<sup>43,44</sup> We also require vessel manufacturers to install only certified engines on new vessels that will be flagged or registered in the United States once emission standards apply. The certificate of conformity (and corresponding engine label) provide assurance that engine manufacturers have met their obligation to make engines that meet the emission standards over the useful life we specify in the regulations.

The scope of application for emission standards for commercial marine diesel engines up to 30 liters per cylinder was established in our 1999 rulemaking (64 FR 73300, December 29, 1999). In that rule, we adopted a set of clarifying definitions that apply to those commercial marine diesel engines and the vessels that use them. We are proposing to apply those definitions to Category 3 marine diesel engines for the purpose of identifying the engines and vessels that must comply with the proposed standards. According to those definitions, which can be found in 40 cfr 94.2, a Category 3 marine diesel engine would be subject to the proposed standards if it is:

- Manufactured after the emission standards become effective, whether domestic or imported;
- Installed for the first time in a marine vessel flagged in the U.S. after having been used in another application subject to different emission standards; or
- Installed on a new vessel flagged in the U.S.

At the same time we are soliciting comment on whether the emission standards should also apply to marine engines on foreign vessels entering U.S. ports and to no longer exclude such

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<sup>43</sup>The term “manufacturer” means any person engaged in the manufacturing or assembling of new engines or importing such engines for resale, or who acts for and is under the control of any such person in connection with the distribution of such engines. 40 CFR 94.2.

<sup>44</sup>For this proposal, we consider the United States to include the States, the District of Columbia, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, Guam, American Samoa, and the Virgin Islands. See CAA section 302(d) definition of “State.”



foreign vessels from the emission standards under 40 CFR 94.1(b)(3). We are inviting comment on whether to modify the definition of a “new marine engine” to find that engine emission standards would apply to Category 1, 2 and 3 marine diesel engines that are manufactured after the standards become effective and that are installed on a foreign flagged vessel that enters a U.S. port. If we were to adopt such an approach, we anticipate the standards would also apply to any marine engine that is installed on a foreign vessel if the vessel is manufactured (or that otherwise become new) after the standards become effective.

We are also proposing to eliminate the foreign trade exemption. Under this exemption, contained in 40 CFR section 94.906(d), engines on vessels flagged or registered in the United States that spend less than 25 percent of total operating time within 320 kilometers of U.S. territory are not required to comply with the proposed limits. This would generally affect auxiliary engines, which are usually less than 30 liters per cylinder.

EPA is not considering inclusion of gas turbines in this rulemaking given the limited amount of information that we currently have about emissions from turbines. EPA’s current belief is that gas turbines generally have lower emissions than diesels. However, we are requesting that commenters provide to us any emissions information that is available as well as whether it would be appropriate to regulate turbines and diesels together. Commenters supporting the regulation of turbines should also address whether any special provisions would be needed for the testing and certification of turbines.

In the remainder of this section we discuss the proposed scope of application of the rule in greater detail.

#### **A. What is a Marine Vessel?**

For the purpose of our marine diesel engine standards, “marine vessel” has the meaning specified in the General Provisions of the United States Code, 1 U.S.C. 3 (see 40 cfr 94.2). According to that definition, the word “vessel” includes “every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water.”

#### **B. What is a Category 3 Marine Diesel Engine?**

In our 1999 commercial marine diesel engine rule, we defined marine engine as an engine that is installed or intended to be installed on a marine vessel. We also differentiated between three types of marine diesel engines. As explained in that rule, this approach is necessary because marine diesel engines are typically derivatives of land-based diesel engines and the land-based engines are not all subject to the same numerical standards and effective dates.

The definitions for the different categories of marine diesel engines are contained in 40 cfr 94.2. Category 1 marine diesel engines, those having a rated power greater than or equal to 37 kilowatts and a specific engine displacement less than 5.0 liters per cylinder, are similar to land-based nonroad engines used in construction and farm equipment. Category 2 marine diesel engines, those having a specific engine displacement greater than or equal to 5.0 liters per

cylinder but less than 30 liters per cylinder, are most often similar to locomotive engines. Category 1 and Category 2 marine diesel engines are used as propulsion engines (i.e., an engine that moves a vessel through the water or directs the movement of a vessel (40 cfr 94.2)) on tugs, fishing vessels, supply vessels, and smaller cargo vessels. They are also used as auxiliary engines (i.e., a marine engine that is not a propulsion engine (40 cfr 94.2)) to provide electricity for navigation equipment and crew service or other services such as pumping or powering winches or anchors.

Category 3 marine diesel engines, which are the primary focus of this proposal, are defined as having a specific engine displacement greater than or equal to 30 liters per cylinder. These are very large engines used for propulsion on large vessels such as container ships, tankers, bulk carriers, and cruise ships. Most of these engines are installed on ocean-going vessels, although a few are found on ships in the Great Lakes. Category 3 marine diesel engines have no land-based mobile source counterpart, although they are similar to engines used to generate electricity in municipal power plants. In marine applications they are either mechanical drive or indirect drive. Mechanical drive engines can be direct drive (engine speed is the same as propeller speed; this is common on very large ships) or have a gearbox (i.e., they have reduction gears; this is common on ships using medium speed Category 3 marine diesel engines). Indirect drive engines are used to generate electricity that is then used to turn the propeller shaft. These are common in cruise ships since they have heavy electricity demands. Category 3 marine diesel engines typically operate at a lower speed and higher power than Category 1 and Category 2 engines, with the slowest speed being 130-200 rpm.

Table III.A-1  
Marine Engine Category Definitions

Category	Displacement per cylinder	hp range (kW)	rpm range
1	disp. < 5 liters (and power $\geq$ 37 kW)	37 - 2,300	1,800 - 3,000
2	$5 \leq$ disp. < 30 liters	1,500 - 8,000	750 - 1,500
3	disp $\geq$ 30 liters	2,500 - 80,000	80 - 900

## C. What is a New Marine Diesel Engine?

### 1. The Current Regulatory Definition

As set out in 40 cfr 94.2, a new marine engine is (i) a marine engine, the equitable or legal title to which has never been transferred to an ultimate purchaser; (ii) a marine engine installed on a vessel, the equitable or legal title to such vessel has never been transferred to an ultimate purchaser; or (iii) a marine engine that has not been placed into service on a vessel. In cases where the equitable or legal title to an engine or vessel is not transferred to an ultimate purchaser prior to its being placed into service, an engine ceases to be new after it is placed into service.

What this means is that a marine engine is new and is subject to the proposed standards before its initial sale is completed or it is placed into service. Practically, it means that any engine must meet the proposed emission standards that are in effect the first time it is sold or placed into service or the first time the vessel on which it is installed is sold or placed into service. This is true for any engine that is sold for the first time as a marine engine (placed into service on a marine vessel), regardless of whether it has previously been used in other nonroad or on-highway purposes. This clarification is necessary because some marine engines are made by “marinizing” existing land-based nonroad or highway engines. Without this clarification a marinized used highway or land-based engine would not be subject to the standards since its title was already transferred to the initial highway or land-based nonroad user.

With respect to imported marine diesel engines, 40 cfr 94.2 defines “new” as an engine that is not covered by a certificate of conformity at the time of importation and that was manufactured after the starting date of the emissions standards which are applicable to such engine (or which would be applicable to such engine had it been manufactured for importation into the United States). According to this definition, the proposed standards would apply to engines that are imported by any person, whether newly manufactured or used, and whether they are imported as uninstalled engines or if they are already installed on a marine vessel that is imported into the U.S. In one example, a person may want to import a vessel built after the effective date of the standards but the engine does not have a certificate of conformity from EPA because the engines and vessel were manufactured elsewhere. We would still consider it to be a new engine or vessel, and it would need to comply with the applicable emission standards. This provision is important to prevent manufacturers from trying to avoid the emission standards by building vessels abroad, transferring their title, and then importing them as used vessels.

## 2. Should Engines on Foreign Flag Vessels That Enter U.S. Ports Be Covered?

Today’s proposal solicits comment on whether to modify the definition of a “new” marine engine to find that engine emission standards apply to Category 1, 2, and 3 marine diesel engines that are built after the standards become effective and that are installed on foreign flag vessels that enter U.S. ports. Such vessels and their engines would be subject to U.S. engine emission standards as a condition of port state entry.

The 1999 marine engine rule did not apply to marine engines on foreign vessels. 40 CFR 94.1(b)(3). At that time we concluded that engines installed on vessels flagged in another country that come into the United States temporarily will not be subject to the emission standards. Those vessels are not considered imported under the U.S. customs laws, and under the interpretation adopted in that rule we did not consider their engines “new” for purposes of Clean Air Act section 213, 42 U.S.C. 7547. 64 FR 73300, 73302 (Dec. 12, 1999).

Section 213 authorizes regulation of “new nonroad engine” and “new nonroad vehicle.” However, Title II of the Clean Air Act does not define either “new nonroad engine” or “new nonroad vehicle.” Section 216 defines a “new motor vehicle engine” to include an engine that has been “imported.” EPA modeled the current regulatory definitions of “new nonroad engine” and “new marine engine” at 40 CFR 89.2 and 40 CFR 94.2, respectively, after the

statutory definitions of “new motor vehicle engine” and “new motor vehicle.” Because “new nonroad engine” is not defined in the statute, EPA is seeking comment on whether “new nonroad engine” could be defined to include marine engines on foreign vessels that enter U.S. ports and that are manufactured after the standards go into effect, whether or not they are considered imported under the U.S. customs laws. EPA also invites comment on whether the term “import,” which is not defined in Title II, should be defined to include foreign flag vessels, for purposes of the definition of “new nonroad engine” only, whether or not they are considered imported under the U.S. customs laws.

EPA has discretion in defining “new nonroad engine” as it is used in Section 213 of the Act. EPA solicits comment on whether it would be appropriate and within EPA’s authority to exercise this discretion to define “new nonroad engine” to include marine engines on foreign vessels that enter US ports, in light of environmental and international oceans policy and any other relevant factors, including consideration of their significant emissions contribution to air quality problems in the United States. If EPA were to regulate foreign-flagged vessels, such vessels would be subject to enforcement as a condition of port entry.

Even if EPA determined that it had the discretion to define “new nonroad engine” as outlined above, EPA could conclude that the most appropriate exercise of its discretion would involve retention of the 1999 definition of “new nonroad engine.” EPA could conclude that revising the definition would not be warranted at this time because of the potential implications that setting engine emission standards for foreign vessels might have on international commerce and future international negotiations under MARPOL and in other fora. EPA will consider, therefore, whether setting a national standard in this situation and changing its interpretation of “new nonroad engine” to apply this standard to foreign vessels could adversely affect the U.S.’ position with respect to the variety of other international issues that are addressed under MARPOL and in other fora. In considering whether to impose requirements on foreign vessels that are more stringent than those imposed on such vessels by their flag states or which may be more stringent than those set out in international instruments (or agreements) , EPA will consider whether this would raise questions of international oceans policy or would have adverse ramifications on U.S. foreign policy. In such a case, it might be more appropriate at this time to exercise any discretion EPA may have by retaining the 1999 definition of “new nonroad engine.”

However EPA decides this issue it would be free to revisit it in the future as appropriate. For example, EPA could revisit any decision to retain the 1999 definition if negotiations with other nations do not lead to international agreement on emissions that adequately protect air quality in the U.S. when foreign vessels enter U.S. ports.

EPA also clarifies that any extension of the rule to foreign flag vessels would not include extension to any warship, naval auxiliary, or other ship owned or operated by a foreign state and used for government noncommercial service.

### 3. Should Engines on Foreign Flag Vessels Be Covered Regardless of the Number of Their Annual Visits?

If we were to apply the standards to engines that are manufactured after the standards become effective and that are installed on foreign flag vessels that enter U.S. ports, one thing to consider is whether this provision should be limited by the number of times a vessel visits U.S. ports annually.

Were we to apply the standards to engines on foreign flag vessels, using a strict approach, any engines on a vessel manufactured (or that otherwise becomes new) after the effective date of the standards, or manufactured before the effective date but has engines that are manufactured after the effective date, that comes to the United States, whether once a year, twenty times a year, or even more, would be required to have compliant engines.

An alternative approach would apply the standards only to those vessels that are frequent visitors to the United States. A review of 1999 data on vessel entrances from the United States Maritime Administration for 1999 indicates that there is considerable variation in the number of vessel entrances per ship. According to that data, which is described in more detail in Chapter 2 of the draft Regulatory Support Document for this rulemaking, there were about 2,500 foreign flag vessels that made only one or two entrances into the United States in 1999. These vessels accounted for 33 percent of all foreign flag vessels that entered this country, but they accounted for only about 5 percent of all vessel entrances. There were about 3,900 foreign flag vessels that entered the United States four or fewer times in that year, accounting for about 52 percent of all vessels, but they accounted for only about 12.5 percent of all vessel entrances. In other words, there is a large set of vessels that come to the United States only a few times a year. The vast majority of entrances by foreign flag vessels, 87.5 percent, are made by about 3,700 vessels that come here 5 or more times a year. We estimate that emissions from engines on foreign flag vessels were on average about 1.7 tons NO<sub>x</sub> per vessel in 2000. This means that foreign vessels that enter U.S. ports only once or twice a year contributed about 6,100 tons of NO<sub>x</sub> in 2000 (about 3 percent of total Category 3 NO<sub>x</sub> emissions of 195,000 tons), and foreign flag vessels that entered U.S. ports four or fewer times a year contributed about 14,500 tons of NO<sub>x</sub> in 2000 (about 7.4 percent of Category 3 NO<sub>x</sub> emissions).

If we were to conclude that it was appropriate under the Clean Air Act to apply the standards to engines on foreign flag vessels, it might be appropriate to exempt engines on foreign-flag vessels that come to the United States only a few times a year. This could be a temporary exemption that would apply only as long as a vessel remains below the threshold number of vessel entrances. To qualify for such an exemption, the shipowner would have to show that the ship does not frequently enter U.S. ports. This demonstration could be made based on the average number of times the vessel entered the United States in the previous two years, for existing vessels, or on the expected usage of the vessel for new vessels (e.g., a regular container or tanker route), for new vessels. In any case, a shipowner that did not obtain an exemption would have to demonstrate in some form that the vessel's engines are compliant. In other words, under such an approach, each foreign flag that seeks to enter a U.S. port would be required to have either a compliant engines or an exemption from the program based on the frequency of its

visits. Under this approach, such a requirement would apply for every trip, not just trips in excess of the threshold number of trips to obtain the exemption.

This alternative relies on the assumption that a vessel that enters the United States only periodically does not have dramatically different number of vessel entrances from year to year. We request comment on whether this is, in fact, the case. Another important aspect of such an exemption for foreign flag vessels, if we were to include them in this rule, is what would happen if the vessel wished to make a third, or fifth, entry into a U.S. port. This is important because of the certification burden associated with making that extra annual trip. The owner of a ship with such an exemption would have to be confident that the vessel would not seek entry more than the allowable number of times. Alternatively, it might be possible to petition EPA for permission to enter an extra time. This might require entering into a settlement agreement in advance of a violation of the terms of the exemption. The settlement could include a fine, a restriction on the number of entries in the future, or some other requirement. We seek comment on this as well as alternative methods to address the case in which a ship would seek to enter U.S. ports in excess of the number of visits specified in the exemption, and on whether obtaining an advance agreement with EPA would be too burdensome.

We request comment on all aspects of this potential alternative. Specifically, we request comment on the number of times a ship should be allowed to enter U.S. ports in a twelve-month period before being required to have compliant engines. We also request comment on whether there is much variability in port entries from year to year for vessels that come to U.S. ports only periodically.

#### **D. What is a New Marine Vessel?**

The definition of new vessel is set out in 40 cfr 94.2. This definition is similar to the definition of new engine: a new marine vessel is a vessel the equitable or legal title of which has never been transferred to an ultimate purchaser. In the case where the equitable or legal title to a vessel is not transferred to an ultimate purchaser prior to its being placed into service, a vessel ceases to be new when it is placed into service. Thus, a vessel is new and must have a certified engine and meet any other requirements for new vessels until its initial sale is completed or it is placed into service.

In addition, a vessel is considered to be new when it has been modified such that the value of the modifications exceeds 50 percent of the value of the modified vessel. As noted in our 1999 rulemaking, this provision is intended to prevent someone from re-using the hull or other parts from a used vessel to avoid emission standards. When applying this provision, the modifications must be completed prior to the effective date of the standards that would otherwise apply. For example, if a second tier of engine standards goes into effect in 2007, modifications that are completed by December 31, 2006 will not trigger the engine requirements and the engines on that vessel would not have to meet the standards. However, if the vessel modifications are completed on or after January 1, 2007, and they exceed 50 percent of the value of the modified vessel, then the engines on the vessel must meet the standards regardless of whether they have been changed as part of the vessel modification.

The definition in 40 cfr 94.2 refers to the “value” of the modifications, rather than the costs. This should therefore be based on the appraised value of the vessel before modifications compared with the value of the modified vessel. The following equation demonstrates the calculation, showing that a vessel is new if:

$$\frac{[\text{assessed value after modifications}] - [\text{assessed value before modifications}]}{[\text{assessed value after modifications}]} \geq 0.5$$

If the value of the modifications exceeds 50 per cent of the final value of the modified vessel, we would treat the vessel as new under 40 CFR part 94. To evaluate whether the modified vessel would be considered new, one would need to project the fair market value of the modified vessel based on an objective assessment, such as an appraisal for insurance or financing purposes, or some other third-party analysis. While the preliminary decision can be based on the projected value of the modified vessel, the decision must also be valid when basing the calculations on the actual assessed value of the vessel after modifications are complete.

#### **E. Would the Foreign Trade Exemption Be Retained?**

In addition to their main propulsion engines, which are generally Category 3 marine diesel engines, ocean-going commercial vessels typically have several Category 1 and Category 2 engines that are used in auxiliary power applications. They provide electricity for important navigational and maneuvering equipment, and crew services.

Several commenters to our earlier marine diesel engine rulemaking expressed concern that requiring ship owners to obtain and use compliant Category 1 and Category 2 engines for vessels that spend most of their time outside the U.S. could be burdensome for those vessels if these engines need to be repaired or replaced when they are away from U.S. ports. Consequently, we provided a foreign trade exemption for these engines. A vessel owner can obtain this exemption for Category 1 and Category 2 marine diesel engines if it can be demonstrated to the Administrator’s satisfaction that the vessel: (a) will spend less than 25 percent of its total engine operation time within 320 kilometers of U.S. territory; or (b) will not operate between two U.S. ports (40 CFR 94.906(d)). Engines that are exempt under this provision must be labeled to indicate that they have been certified only to the MARPOL Annex VI NO<sub>x</sub> curve limits and that they are for use solely on vessels that meet the above criteria.

Today, we are proposing to eliminate this foreign trade exemption because the conditions that led to the need for it no longer hold. Specifically, we have learned that many engine spare parts are kept onboard vessels to enable ship operators to perform maintenance and repairs while the ship is underway. In addition, obtaining parts that are not kept onboard is not expected to be a problem. Modern package delivery systems should allow ship owners to obtain parts quickly, even overnight, and necessary parts can be shipped to the next convenient port on a ship’s route. In the unlikely case that an engine fails catastrophically and must be replaced by a compliant engine, we are confident that the ship operator will be able to make arrangements to obtain a certified engine since the major manufacturers of marine diesel engines operate abroad as well as in the United States. Because the burden associated with repairing or replacing engines away

from the United States is not significant, we believe it is appropriate to eliminate the exemption. We do not expect this change to have any impact on shipowners and operators, however, we request comments on the elimination of this exemption. Would this change have any measurable impact on U.S. flag shipowners or operators? Would it put U.S. flag shipowners or operators at a competitive disadvantage, in particular if a Tier 2 standard is included in the final rule? If so, please provide information supporting this concern.

#### **IV. Standards and Technological Feasibility**

##### **A. What engine emission standards are under consideration?**

Manufacturers of Category 3 marine engines have available a wide range of technologies to control emissions. Many of these technologies are similar to those that have been developed for smaller nonroad and highway diesel engines. While Category 3 marine engines are much larger than other regulated diesel engines, many of the same engineering principles of emission formation and control apply. In fact, manufacturers have applied significant effort to reduce emissions from these engines, both to meet Annex VI NO<sub>x</sub> standards and to develop technologies to address concerns in specific areas. At the same time, it is clear that a substantial opportunity remains to adapt technologies to Category 3 marine engines

The following discussion of emission standards and the associated control technologies applies without respect to whether the standards ultimately apply only to U.S.-flag vessels or to all vessels calling on U.S. ports. Engine technology has become a very global field, with emission-control technology and compliant engines coming from all parts of the world. Manufacturers and owners of foreign-flag vessels would not face any unique constraints in using engines certified to EPA emission standards compared with U.S.-flag vessels. Nevertheless, we are proposing emission standards only for engines installed on U.S.-flag vessels, so references in this section to Category 3 marine engines apply specifically to those engines that would be subject to the proposed emission standards, unless otherwise noted.

Clean Air Act section 213 directs EPA to adopt standards requiring:  
...the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available for the engines or vehicles to which such standards apply, giving appropriate consideration to the cost of applying such technology within the period of time available to manufacturers and to noise, energy, and safety factors associated with the application of such technology.  
To implement this Clean Air Act directive, we are seeking comment on two separate tiers of emission standards for new marine diesel engines, as described below.

This section also describes an approach for setting Tier 2 HC and CO standards, applying Tier 1 standards to engines between 2.5 and 30 liters per cylinder, and defining voluntary low-emission standards.



## 1. Tier 1 Emission Standards

We propose to adopt a first tier of standards starting in the 2004 model year<sup>45</sup> equivalent to the Annex VI NOx limits. Manufacturers have introduced basic emission-control technologies for all types of marine diesel engines in response to the Annex VI standards. This effort has demonstrated the feasibility of in-cylinder technologies including optimized turbocharging, higher compression ratio, and optimized fuel injection, which generally includes timing retard and changes to the number and size of injector holes to increase injection pressure.

As described in Section V, we are proposing to accept emission data for Tier 1 certification based on testing with either distillate or residual fuel. Since most or all manufacturers have been using distillate fuel to comply with Annex VI requirements, we expect manufacturers to meet Tier 1 standards generally by submitting their available emission data from testing with distillate fuels. However, since Annex VI does not include detailed specifications for test fuels, we believe that we will need to correct emission data for the effect of fuel nitrogen content. This correction is described later in this section. We would require that certified engines continue to meet Tier 1 emission standards throughout their useful life when tested with either distillate or residual fuel, after correction for the effect of fuel nitrogen. The proposed Tier 1 NOx limits, reflecting the fuel adjustment, are set out in Table IV.A-1.

Table IV.A-1  
Proposed Tier 1 NOx Emission Limits (g/kW-hr)\*

Engine Speed (n)	n ≥ 130 rpm**	n < 130 rpm
Tier 1	$45.0 \times n^{-0.2} + 1.4$	18.4

\*The proposed regulations specify emission standards based on testing with measured emission values corrected to take into account the nitrogen content of the fuel. Emission values are corrected to values consistent with testing engines with fuel containing 0.4 weight percent nitrogen. Testing with fuel containing 0.2 weight-percent nitrogen (typical for in-use distillate marine fuels) would have a correction of 1.4 g/kW-hr, so the proposed Tier 1 NOx standards would match the Annex VI NOx standards at this test point.

\*\*No cap would apply to engines over 2000 rpm, because Category 3 engines all have engine speeds well below that speed.

We are also proposing to apply the Tier 1 standards to all marine diesel engines with specific displacement between 2.5 and 30 liters per cylinder. This would apply to these engines from 2004 to 2006, after which the EPA Tier 2 marine engine emission standards established in December 1999 would apply (64 FR 73300, December 29, 1999). All testing to show compliance for these engines would be based on testing with distillate fuels meeting the

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<sup>45</sup> We are proposing to base model years on the date on which the engine is first assembled. In other rules, we have defined the date of manufacture to be the date of the final assembly of the engine. However, we recognize that Category 3 engines are often disassembled for shipment to the site at which it is installed in the ship.

specifications in 40 CFR 94.108.<sup>46</sup> As with the Category 3 engines, this would merely formalize the Annex VI standards, which these engines should already meet. Including these engines in this proposal would remove any ambiguity regarding the applicability of emission standards. We are not proposing to include engines under 2.5 liters per cylinder, because the December 1999 emission standards generally start already in 2004. Marine diesel engines below 0.9 liters per cylinder need not meet EPA emission standards until 2005. Most of those engines are under 130 kW and are therefore not subject to Annex VI standards.

## 2. Effect of Fuel Variables on Emission Standards

Another objective of the Clean Air Act is to adopt test procedures that represent in-use operating conditions as much as possible, including specification of test fuels consistent with the fuels that compliant engines will use over their lifetimes. This raises the question of testing Category 3 marine engines with distillate and residual fuel. Distillate fuel has a higher quality than residual fuel, but costs significantly more, so vessels with Category 3 marine engines primarily use residual fuel. The Annex VI emission standard is based on allowing manufacturers to test with marine distillate fuels, which generally have nitrogen levels of 0.0 to 0.4 weight percent. As discussed in the Draft Regulatory Support Document, NO<sub>x</sub> emission levels increase with greater amounts of nitrogen that are bound up in the fuel. Residual fuels generally have higher nitrogen concentrations (typically 0.2 to 0.6 weight percent).

We are proposing that manufacturers of Category 3 engines may certify that they meet the applicable emission standards using either distillate or residual fuel. The proposed regulations include a range of fuel specifications for each fuel type (40 CFR 94.108). However, for testing engines after installation in the vessel, we would expect manufacturers to use residual fuel. This would add assurance that emission-control technologies reduce emissions under real operation in vessels. Without this assurance, manufacturers could implement and optimize technologies to achieve substantial emission control with distillate fuel without necessarily reducing emissions when engines operate with residual fuel.

To appropriately account for the emission-related effects of fuel quality, we analyzed the effect of nitrogen in contributing to NO<sub>x</sub> emissions. The first step is to assign a default nitrogen content for distillate fuels as a benchmark to properly characterize the Annex VI NO<sub>x</sub> standards. Fuel sampling shows an average concentration of 0.2 percent nitrogen in distillate fuel by weight (i.e., weight percent).<sup>47</sup> The comparable average value for residual fuels is 0.4 weight percent. To adjust the standard for testing with high-nitrogen residual fuel, we calculated the amount of additional NO<sub>x</sub> that would form if all the additional fuel-bound nitrogen would react to form NO<sub>x</sub>. This calculation depends on assigning a value for brake-specific fuel consumption, for

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<sup>46</sup>Without the fuel-based corrections described below, the proposed Tier 1 standards for these engines default to  $\text{NO}_x = 45.0 \times n^{-0.2}$ , with emissions capped at 9.8 g/kW-hr for engine speeds over 2000 rpm.

<sup>47</sup>Lloyds report.

which we use 220 g/kW-hr.<sup>48</sup> The resulting correction of 1.4 g/kW-hr shows up as an additive term in the equation in Table IV.A-1, since it is a constant value (independent of speed), assuming a consistent brake-specific fuel consumption rate.<sup>49</sup> For all testing with Category 3 engines, we would require measuring fuel-bound nitrogen and correcting measured values to what would occur with a nitrogen concentration of 0.4 weight percent (see Section V). This corrected value would be used to determine whether the engine meets emission standards or not. This correction methodology would apply equally to testing with distillate or residual fuels. Note that Annex VI includes a 10-percent allowance for higher emissions when performing simplified in-use testing with residual fuel. However, we believe that the nitrogen-based correction for any testing with any fuel is a better way to ensure that the targeted emission reductions are achieved in use.

This proposed approach to account for fuel nitrogen would help us ensure that engines meet the targeted level of emission control for the whole range of in-use fuels. At the same time, it allows substantial testing flexibility without compromising our ability to set an emission standard requiring the greatest degree of emission reductions for any given fuel. We request comment on this approach to testing with distillate and residual fuels. In particular, we request comment on the appropriate adjustment in the emission standard to account for the effects of testing with residual and distillate fuels in general and fuel-bound nitrogen in particular. We also request comment on how this approach to test fuels affects the cost of emission testing.

### 3. Tier 2 Emission Standards

EPA is considering adoption of a second tier of standards that would reflect additional reductions that could be achieved through engine-based controls and would apply to new engines built after 2006 or later. The year that EPA considers most appropriate at this time is 2007. The NO<sub>x</sub> standards we are considering for potential Tier 2 standards are based on a 30 percent reduction from Tier 1 to allow manufacturers both greater flexibility in choosing the combination of emission control technologies to apply to their engines and a compliance margin for certification purposes. The NO<sub>x</sub> limits we are considering for a second tier of standards are contained in Table IV.A-2.

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<sup>48</sup> “Commercial Marine Emissions Inventory Development, Draft Final Report,” EPA Work Assignment Number 1-1, Prepared by ENVIRON International Corporation, April 2002..

<sup>49</sup>In contrast, Annex VI and the proposed Tier 1 standards allow for a 10-percent increase in emissions when testing with residual fuel, which makes the fuel correction a function of engine speed. For most Category 3 engines, 1.4 g/kW-hr is roughly 10 percent of the Annex VI NO<sub>x</sub> emission standard.

Table IV.A-2  
Tier 2 Standards Currently Under Consideration  
NOx Emission Limits (g/kW-hr)\*

Engine Speed (n)	n ≥ 130 rpm**	n < 130 rpm
Tier 2	$31.5 \times n^{0.2} + 1.4$	13.3

\*See notes to Table IV.A-1.

\*\*See notes to Table IV.A-1.

Control of diesel engine emissions typically focuses on NOx and PM emissions. HC and CO limits for diesel engines generally receive less attention because the diesel combustion process inherently prevents high rates of HC and CO emissions. We estimate that HC emissions are currently at 0.4 g/kW-hr, which is significantly lower than NOx emissions from Category 3 engines, even after manufacturers substantially reduce NOx emissions. Hydrocarbon emissions nevertheless combine with NOx emissions to form ozone. We have generally adopted emission standards for other types of diesel engines in the form of a single standard for combined NOx and HC emissions. To prevent increases in HC emissions, we are considering a Tier 2 standard at the baseline level of 0.4 g/kW-hr. This may achieve modest reductions in HC emissions, but more importantly would prevent HC emission increases that might otherwise result from controlling NOx emissions alone. We request comment on whether we should set an emission standard for HC emissions and how to best to set an appropriate standard if one is warranted. We further request comment on setting a combined NOx+HC standard for Category 3 engines as part of a second tier of standards. Commenters supporting a NOx+HC standard should also address how to use NOx-only onboard emission measurements in the context of a NOx+HC standard, since it may not be possible to measure HC emissions.

We do not expect manufacturers to apply control technologies to reduce CO emissions. In fact, for current technologies, CO emissions generally decrease as manufacturers improve fuel consumption rates, so there is no incentive that would lead manufacturers to increase CO emissions. In other EPA programs for diesel engines, we generally set CO emission standards to prevent emission increases over time. We are considering this same approach with Tier 2 standards for Category 3 marine engines. Uncontrolled CO levels are generally less than 1 g/kW-hr. We are therefore considering a Tier 2 emission standard of 3 g/kW-hr for these engines, which would ensure that manufacturers don't cause significant increases in CO emissions when applying technologies designed to address NOx emissions. A tighter standard may cause a manufacturer to spend a disproportionate amount of effort developing emission-control technologies for small changes in CO emissions. We request comment on regulating CO emission levels this way and specifically whether this is an appropriate level for a CO emission standard.

Regarding PM from Category 3 marine engines, the majority of emissions comes directly from the high concentration of sulfur in the fuel. Short of changing in-use fuel quality, emission-control technologies only address the remaining portion of PM, since engine technologies are ineffective at reducing sulfur-related PM emissions. Furthermore, no acceptable procedure exists for measuring PM from Category 3 marine engines, because current established PM test methods

show unacceptable variability when sulfur levels exceed 0.8 weight percent, which is common for both residual and distillate marine fuels for Category 3 engines. No PM test method or calculation methodology has been developed to correct that variability for these engines. For these reasons, we are not considering a PM standard for Category 3 engines. We request comment on our approach; commenters supporting PM emission standards should address these issues and suggest an appropriate standard reflecting an achievable level of control, considering costs and other statutory factors. See the section below for discussion of regulating in-use fuels to achieve PM, SO<sub>x</sub>, and possibly additional NO<sub>x</sub> reductions.

Testing has shown that optimizing engine systems and developing additional control technologies will allow manufacturers of Category 3 marine engines to meet emission standards more stringent than Annex VI levels. Such improvements will require additional time. . As discussed in Section IV.C, we believe manufacturers can achieve these proposed emission standards by further optimizing their designs and developing additional technologies for better control of fuel injection, charge air induction and mixing, and the overall design of combustion chambers and the timing of combustion events. We request comment on the level of the Tier 2 standards. Section IV.B discusses the timing of introducing the proposed Tier 1 standards and the Tier 2 standards under consideration.

#### 4. Emission Effects of Test Conditions and Engine Operating Modes

Section V describes how we propose to address varying test conditions for emission measurements to show that engines meet emission standards when operated over the ISO E3 duty cycle. In general, we define a range of conditions for barometric pressure, humidity, ambient air temperature and ambient water temperature for testing according to the proposed duty cycle. Weighted engine emissions may not exceed the emission standards within the specified ranges of ambient conditions. For humidity and ambient water temperature, we specify a proposed method for correcting emission levels to a reference condition. We don't propose to allow any correction or adjustment based on varying ambient air temperatures or barometric pressures within the specified ranges. The specified ranges of test conditions apply to both laboratory testing and testing onboard a vessel. We are also proposing other provisions that would require equivalent emission control under other ambient conditions.

An additional concern relates to the way emissions vary under different engine operating conditions. For Category 1 and Category 2 engines, we adopted "not-to-exceed" provisions to define an objective measure to ensure that engines would be reasonably controlling emissions under the whole range of expected normal operation, as well as the defeat-device prohibition. Since these smaller engines are mass produced for a wide range of vessels used in many different applications, we expected "normal operation" for these engines to vary considerably around the ideal propeller curve. We are not considering not-to-exceed standards for Category 3 engines, since each engine intended to operate on a propeller curve is matched with a propeller for custom installation on a specific vessel. Also, the very large mass of ocean-going vessels make them relatively insensitive to perturbations caused by varying vessel loads, water currents, or weather conditions. As a result, engine operation should invariably be limited to a very narrow range around the propeller curve. Propulsion engines that operate at constant speed (whether coupled

to a variable-pitch propeller or generator for electric-drive units) will similarly operate over a very narrow range. Moreover, we are considering a requirement that manufacturers test their production engines after installation on the vessel to show compliance with Tier 2 emission standards, which further removes the possibility of engines departing significantly from areas of engine operation over for which they are demonstrated to control emissions.

The proposed ISO E3 duty cycle includes four test modes weighted to reflect the operation of commercial marine vessels. The modal weightings are based on 70 percent of engine operation occurring at 75 percent or more of the engine's maximum power. For Category 1 and Category 2 engines, we have applied this same duty cycle, which reflects the way such engines are expected to operate. We are concerned, however, that Category 3 engines operate at significantly lower power levels when they are operating within range of a port. Ship pilots generally operate engines at reduced power for several miles to approach a port, with even lower power levels very close to shore. Because of the relatively low weighting of the low-power test modes, it is very possible that manufacturers could meet emission standards without significantly reducing emissions at the low-power modes that are more prevalent for these engines as they operate close to commercial ports. This issue would generally not apply to vessels that rely on multiple engines providing electric-drive propulsion, since these engines can be shut down as needed to maintain the desired engine loading.

We are considering a variety of options to address this concern. We could re-weight the modes of the duty cycle to emphasize low-power operation. This has several disadvantages. For example, we have no information to provide a basis for applying different weighting factors. Also, changing the duty cycle would depart from the historic norm for marine engine testing. This would make it more difficult to make use of past emission data, which is all based on the established modal weighting. An alternative approach would be to cap emission rates at the two low-power modes. We could set the cap at the same level as the emission standard, or allow for a small variation above the emission standard. For mechanically controlled engines, such an approach could dictate the overall design of the engine. On the other hand, we expect most or all new engines to have electronic controls, which would enable the manufacturer to target emission controls specifically for low-power operation without affecting the effectiveness of emission controls at higher power. We request comment on the need to adopt special provisions to ensure appropriate control of emissions during low-power operation. We specifically request comment on an additional requirement to limit emission levels of the two low-power modes to the level of the NO<sub>x</sub> emission standard for each engine.

An additional concern relates to variation in emission levels between test modes. The proposed defeat device provisions (which already apply to Category 1 and Category 2 engines) would prevent manufacturers from producing their engines to control emissions more effectively at established test points than at other points not included in the test. This is especially important for Category 3 engines that leave the U.S., because we are expecting ship operators to measure emissions to show that the engines still meet emission standards within a certain range of a U.S. port. As described in Section V.B.10, outside the U.S., ship operators may make adjustments outside the range of adjustable parameters to which the engine is certified. Engine manufacturers would be required to develop emission targets to allow the operator to ensure that the engine has

been readjusted to the certified configuration. These emission targets would vary with operating conditions and would include targets for engine speeds other than the test points speeds. We are proposing that Category 3 engine manufacturers design their engines to achieve equivalent control for varying engine speeds after any changes are made to compensate for changes such as switching fuels. In identifying the NOx emission targets, manufacturers would have the choice of either applying the same injection timing map for the tested and nontested engine speeds, or ensuring that NOx emissions for nontest speeds follow a linear interpolation between test points. Ship operators would be required to adjust their engines to have NOx levels below the target level.

## 5. Voluntary Low-Emission Standards

We are also proposing voluntary low-emission standards, consistent with the approach we have taken in several other programs, to encourage the introduction and more widespread use of low-emission technologies. Manufacturers would need to reduce emissions 80 percent below Annex VI levels (excluding the nitrogen adjustment), as shown in Table IV.A-1, to qualify their engines for designation as voluntary low-emission engines. These reduced emission levels would apply to testing with both residual and distillate fuels, with the appropriate adjustments for nitrogen content of the fuel. Data show that engines utilizing selective catalytic reduction are capable of meeting these emission levels. If we establish an objective qualifying level for voluntary low-emission engines, this would make it easier for state and local governments or individual port authorities to develop meaningful incentive-based programs to encourage preferential use of these very low-emitting engines.

Engines certified to the voluntary low-emission standards would also need to meet HC and CO levels at levels we are considering for the second tier of standards. The voluntary low-emission standards are contained in Table IV.A-3.

Table IV.A-3  
Proposed Blue Sky NOx Emission Limits (g/kW-hr)\*

Engine Speed (n)	n ≥ 130 rpm**	n < 130 rpm
Blue Sky	$9.0 \times n^{-0.2} + 1.4$	4.8

\*See notes to Table IV.A-1.

\*\*See notes to Table IV.A-1.

## 6. Hotelling Emissions

In addition to emissions from engines while the ship is moving in port, many ships run one or more engines to produce electricity for ship operations while in port for loading and unloading. These emissions are concentrated locally in the port area, which may have a disproportionate effect on neighboring communities. Several options are available specifically to address this concern for “hotelling” emissions. Many of these go beyond our usual approach of setting emission standards for new engines, but we request comment on these and other possible

approaches, given the potential to achieve substantial additional reductions in this area.

Focusing on port emissions raises several questions. (1) Would it be appropriate for regulatory provisions to focus on reducing emissions specifically from port facilities, including hotelling emissions from ships? (2) Should EPA provide targets or incentives to encourage port authorities to reduce overall port emissions, including land-based equipment and vehicles? (3) What form might such a policy take—regulatory, voluntary, administered by EPA or local governments, including financial or logistical incentives? (4) Is it appropriate to adopt national policies to ensure emission reductions in all port areas or should such policy development be tailored to port-specific concerns? (5) Should EPA emission standards differentiate between in-port and transit emission levels? If so, what form or emission levels would be appropriate for in-port operations?

While we are not proposing to take action to address hotelling or other in-port emissions separately, we request comment on these issues and on any other possible approaches to encourage or ensure that emission controls are applied appropriately in port areas.

#### **B. When would the engine emission standards apply?**

Proposing emission standards for new Category 3 marine engines starting in 2004 allows less than the usual lead time for meeting EPA requirements. We note, however, that manufacturers are already meeting the Annex VI standards, which apply to engines installed on vessels built on or after January 1, 2000. The Tier 1 standards proposed in this document require no additional development, design, or testing beyond what manufacturers are already doing to meet Annex VI standards.

Under the proposed EPA regulations, engine manufacturers would need to comply with emission standards for all engines produced after the specified date. This date would be based on the point of final engine assembly, which for large Category 3 marine engines typically occurs when the engine is installed in the vessel. Shipbuilders and owners would not be responsible for meeting EPA standards, but we are proposing to apply the prohibition from 40 CFR 94.1103(a)(5), which prevents shipbuilders from selling vessels with noncompliant engines if they initiate construction of a vessel after the date that regulations begin to apply. This raises a question about vessels whose keel is laid before new standards take effect if vessel completion does not occur until after standards take effect. This question is best addressed by an example—if EPA were to adopt Tier 2 standards that would apply in January 2007 and if a ship's keel is laid in June 2006, with final vessel assembly in June 2007, that vessel could use Tier 1 engines only if the engine manufacturer completes the engine assembly before January 1, 2007. This should not be an issue for Tier 1 engines, since vessels are generally already using engines that meet Annex VI NO<sub>x</sub> limits.

As described in the Draft Regulatory Support Document, manufacturers are well underway in pursuing emission-control technologies that would reduce emissions from Category 3 marine engines beyond Annex VI levels. If EPA were to adopt Tier 2 standards in a final rule in 2003, manufacturers would have four years to implement technologies needed to meet such standards



by 2007. This would include time in the early years for selecting specific approaches and developing those technologies. Manufacturers would also need that time to integrate the various technologies into an overall engine design that performs well and is durable. Given that engine manufacturers already have limited experience in applying these technologies to Category 3 marine engines, we believe the Tier 2 standards will be achievable in the time frame under consideration. In addition, Tier 2 emission standards are already scheduled to apply to Category 2 engines in 2007. To the extent that some Category 3 engines compete directly with Category 2 engines, sharing an implementation date helps in maintaining a level playing field between competitive engines. We request comment on the implementation dates for the Tier 2 program under consideration.

**C. What information supports the technological feasibility of the engine emission standards?**

Annex VI calls for marine diesel engines over 130 kW to meet emission standards if they are installed on vessels built on or after January 1, 2000. Engine manufacturers are meeting the Annex VI standards today with a variety of emission-control technologies. Chapter 4 of the Draft Regulatory Support Document identifies several technologies that individual manufacturers have already incorporated to reduce emissions. The most common approach has been to focus on increased compression ratio, adapted fuel injection, valve timing and different fuel nozzles to trim NO<sub>x</sub> emissions. Manufacturers have generally been able to do this with little or no increase in fuel consumption. By building engines that can meet the Annex VI standards, manufacturers have shown that they can meet the identical Tier 1 standards proposed here for Category 3 marine engines.

As described in the Draft Regulatory Support Document, we have relied on existing data to account for fuel effects in selecting the proposed Tier 1 and potential Tier 2 NO<sub>x</sub> emission standards for testing Category 3 marine engines with residual fuel. Engines designed to meet Annex VI NO<sub>x</sub> standards using in-use distillate fuels should be able to meet the proposed Tier 1 standards without adopting any new technologies.

While manufacturers have used a wide variety of technologies to meet Annex VI standards for Category 3 marine engines, engines have so far generally incorporated only a few of the available emission-control technologies. To meet more stringent standards, manufacturers would need to integrate Tier 1 technologies more broadly into the fleet and pursue several additional approaches. These include:

- Improved fuel injection. This includes injection timing, injection pressure, rate shaping (or split injection), and common rail injection systems. Electronic controls would also allow for more precise metering and timing of individual injections.
- Intake air management. Manufacturers can use more effective turbocharging and aftercooling to reduce NO<sub>x</sub> emissions. Also, valve timing can be manipulated to vary expansion and compression ratios or to recirculate exhaust gases.
- Combustion chamber modifications. Several design variables affect the compression and mixing of the fuel-air mixture before and during combustion, including higher compression ratios, piston geometry, and injector location.

Test data show that these technologies can reduce emissions up to 40 percent below Annex VI NOx standards.<sup>50</sup> We believe manufacturers could incorporate emission-control technologies to achieve a 30-percent reduction below Annex VI standards for all their Category 3 marine engines. Some industry representatives have indicated that this level of control is achievable.<sup>51</sup> Specifying 30 percent instead of 40 percent allows for a compliance margin for manufacturers to ensure that they meet emission standards consistently with all the engines they produce in an engine family. This also allows for manufacturers to show that they meet emission standards under the range of prescribed testing and operating conditions, as described above, including measures to cap emission levels at low-power modes to the level of the proposed emission standards. These technologies, and accompanying emission data, are described in more detail in Chapter 4 of the Draft Regulatory Support Document, while Chapter 5 adds specific detail regarding our estimated deployment of each of the targeted control technologies in the analysis to develop costs estimates related to the emission standards.

The analysis of emission-control technologies in most cases applies equally to two-stroke and four-stroke engines. While there are many fundamental differences between these types of engines, most emission-control strategies could be applied effectively to both types. Perhaps the most significant difference between these engines is the tendency for significantly larger displacements and slower operating speeds with two-stroke engines. The emission standards for Category 3 marine engines incorporate the same shape of the NOx curve specified by Annex VI (and shown in Table IV.A-1), which reflects the generally increasing NOx emission levels for larger engines with slower operating speeds. The emission standards therefore implicitly take into account higher emission levels for two-stroke engines.

Section VII discusses a range of alternative approaches we considered in developing this proposal and explains our reasons to defer their adoption at this time.

If we adopt Tier 2 standards as part of this rulemaking, we intend to revisit and reopen the Tier 2 standards in approximately 2005. At that time we would fully reassess the circumstances and re-determine the appropriate level of the standards. We believe it is important to preserve our ability to coordinate our actions under the Clean Air Act with the future actions of the U.S. government involving MARPOL. To maximize this coordination and to allow for all appropriate harmonization, we would establish a rulemaking schedule for a future reopening and revisiting of any Tier 2 standards. In this future rulemaking we would reconsider the level of any Tier 2 standards based on all the circumstances then present, including the information then available concerning technological feasibility, cost, and other relevant aspects of emissions control for

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<sup>50</sup> Ingalls, M., Fritz S., "Assessment of Emission Control Technology for EPA Category 3 Commercial Marine Diesel Engines," Southwest Research Institute, September 2001 (Docket A-2001-11, document II-A-08).

<sup>51</sup> Mayer, Hartmut, Euromot, e-mail response to EPA questions, January 31, 2002 (Docket A-2001-11, II-D-01).

these engines, as well as the then current status of emissions standards under MARPOL. This reconsideration could lead to revised Tier 2 standards to reflect the appropriate level of the standard under the Clean Air Act based on the circumstances present at that time. We would implement this process by adopting in this rule a specific schedule for a future rulemaking, including for example a set date for final action on the future rulemaking.

#### **D. Is EPA considering not adopting Tier 2 Standards in this rulemaking?**

EPA is also considering not adopting Tier 2 standards in this rulemaking, and instead establishing a schedule for a future rulemaking and addressing Tier 2 standards in that future rulemaking. For these reasons, EPA has not included proposed regulations in this Notice. In that future rulemaking, EPA would propose and establish appropriate Tier 2 standards based on an assessment of all of the circumstances then present, including the information then available concerning technological feasibility, cost, and other relevant aspects of emissions control for these engines, as well as the then current status of emissions standards under MARPOL. This would be similar to the reopening rulemaking discussed above, involving reopening of any Tier 2 standards adopted in the current rulemaking. However, instead of revisiting Tier 2 standards adopted in the current rulemaking, under this alternative no Tier 2 standards would be set until the future rulemaking. The schedule for the future rulemaking would be the same as that discussed above, approximately 2005, and as with the reopening rulemaking this schedule would be included in the regulations adopted in this rulemaking.

The benefit of this alternative would stem from its potential to facilitate the international process of updating the Annex VI emissions standards. As discussed earlier in this preamble, EPA anticipates that further discussions will be held at the IMO, in the Marine Environment Protection Committee, concerning adoption of a second, more stringent level of emissions standards. If delaying the initial establishment of Tier 2 standards to a future rulemaking facilitates the successful completion of updating the Annex VI emissions standards, the overall environmental result might be better than adoption of Tier 2 standards in this rulemaking. In addition, it could facilitate EPA's actions to harmonize its regulations as appropriate with future Annex VI provisions. This future rulemaking would occur whether or not Annex VI negotiations were concluded by that date. Delaying setting Tier 2 standards until a future rulemaking, however, also raises the issue of whether adoption in this rulemaking of only Tier 1 standards and establishment of a schedule for a future Tier 2 rulemaking would be consistent with the Agency's obligations under the Clean Air Act. EPA invites comment on all issues associated with this alternative.

#### **E. Is EPA considering any fuel standards?**

The majority of Category 3 engines are designed to run on residual fuel. This fuel is made from the very end products of the oil refining process, formulated from residues remaining after the primary distilling stages of the refining process. It has higher contents of ash, metals, and nitrogen that may increase exhaust emissions. Residual also has sulfur content up to 45,000 ppm; the global average sulfur concentration is currently about 27,000 ppm, though fuel sold in

the U.S. has sulfur levels somewhat above the average.<sup>52</sup> Operating on fuels with such high sulfur contents results in high SOx and direct sulfate PM emissions.

Using a residual fuel with a lower sulfur content would reduce the fraction of PM emissions from ash and metals. Using distillate fuel instead of residual fuel could result in even lower emissions. The simpler molecular structure of distillate fuel may result in more complete combustion with reduced levels of carbonaceous PM. Operation on distillate fuel would also reduce NOx emissions because distillate fuel generally contains less nitrogen and has better ignition qualities. Because of these benefits, we request comment on fuel controls to reduce exhaust emissions from Category 3 marine engines.

MARPOL Annex VI contains requirements for fuels used onboard marine vessels. These requirements, which will be effective when the Annex goes into force, consist of two parts. First, Annex VI specifies that the sulfur content of fuel used onboard ships cannot exceed 45,000 ppm (4.5 percent). Information gathered in an international monitoring program indicates refiners are currently complying with this requirement. Second, the Annex provides a mechanism to designate SOx emission control areas, within which ships must either use fuel with a sulfur content not to exceed 15,000 ppm or an exhaust gas cleaning system to reduce SOx emissions. To date, two SOx emission control areas have been designated: the North Sea and English Channel, and the Baltic Sea. The Annex VI fuel provisions do not go into effect, however, until the Annex enters into force (see Section I.C. above).

Operators who choose not to use exhaust gas cleaning systems can meet the Annex VI SOx requirement by using low-sulfur residual fuel or by switching to distillate fuel while they operate in SOx Emission Control Areas. Due to the nature of distillate fuel, this would also reduce NOx emissions. In general, engines that are designed to operate on residual fuel oil are capable of operating on distillate fuel. For example, if the engine is to be shut down for maintenance, distillate fuel is often used to flush out the fuel system. However, there are several complications associated with this option. Switching to distillate fuel requires 20 to 60 minutes, depending on how slowly the operator wants to cool the fuel temperatures. According to engine manufacturers, switching from a heated residual fuel to an unheated distillate fuel too quickly could cause damage to fuel pumps. There could also be fuel pump durability problems if the engine is operated on distillate fuel for more than a few days. For continued operation on distillate fuel, ships would need to have separate (or modified) pumps and lines. In addition, modification to the fuel tanks may be necessary to ensure sufficient capacity for low-sulfur fuel.

Alternatively, ships can use residual fuels produced to meet the 15,000 ppm (1.5 percent) sulfur requirement. Refiners can produce low-sulfur residual fuel from a low-sulfur crude oil or they can put the fuel through a de-sulfonation step in the refinery process. They can also produce it by blending marine distillate fuel, which typically has fuel sulfur levels between 2,000 and

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<sup>52</sup>Sulphur Monitoring 2002. Report to Marine Environmental Protection Committee, 47<sup>th</sup> Session. MEPC 47/INF.2, August 28, 2001. A copy of this document can be found in Docket A-2000-11.

3,000 ppm.

Given the PM, and SO<sub>x</sub> benefits of using low-sulfur residual fuels and the added NO<sub>x</sub> benefit of using distillate or distillate-blend fuels, we are requesting comment on whether we should set standards for the fuel that ships use. We are also seeking comment on what form such fuel standards should take. For example, we could adopt the Annex VI special control area sulfur limits, either through the Annex VI process or through regulation under the Act. This would set a maximum sulfur limit of 15,000 ppm. However, lower sulfur contents are feasible and would yield greater PM and SO<sub>x</sub> benefits. As a comparison, the sulfur content of highway diesel fuel is under 500 ppm today, with a 15-ppm cap applying starting in 2007. The sulfur content of nonroad diesel is not regulated, but generally ranges from 2,000 to 3,000 ppm. Reducing the sulfur content of the fuel would reduce PM and SO<sub>x</sub> emissions by 10 and 44 percent, respectively (see Chapter 4 of the Draft Regulatory Support Document). An alternative approach would be to require that ships use distillate fuels, which would achieve the same or greater reduction of PM and SO<sub>x</sub> emissions, with an additional 10-percent reduction in NO<sub>x</sub> emissions resulting from the decreased nitrogen content of the fuel. Chapter 5 of the Draft Regulatory Support Document presents costs estimates for these fuel-based regulatory options. We request comment on these possible approaches to addressing in-use fuel quality.

We also seek information on the costs and expected benefits of further reductions in allowable fuel-sulfur levels, for both ship owners and fuel suppliers. Finally, we seek comment on how to apply the standard. Historically, we have regulated in-use fuels by establishing minimum specifications that apply to those who sell the fuel. This approach may not be effective for this sector because ship owners could choose to purchase their fuel outside the U.S. If we don't adopt any requirements related to in-use fuels in this rulemaking, we could revisit these questions in the context of a technology review, as described above

We are not proposing fuel-based regulations in this rule because regulating fuel sold in the U.S. would not necessarily ensure that distillate fuel was used in U.S. waters. The Clean Air Act limits us to setting requirements on fuel entered into commerce in the U.S. If we can regulate only the fuel sold in the U.S., then a fuel sulfur standard would be unlikely to have a significant impact on emissions because ships may choose to bunker before entering or after leaving the U.S. However, Regulation 14 of MARPOL Annex VI allows areas in need of SO<sub>x</sub> emission reductions to petition to be designated as SO<sub>x</sub> Emission Control Areas (SECA). Within such waters, the maximum sulfur content of the fuel will be limited to 15,000 ppm.<sup>53</sup> We intend to work through the MARPOL process to designate certain areas in the U.S. as sulfur control areas which would require the use of distillate fuel. We request comment on whether all waters under U.S. jurisdiction or only specific areas should be designated as SECAs, and whether such designation(s) could be expected to have an adverse impact on port traffic within SECAs. EPA also invites comment on our authority under the Clean Air Act to regulate this fuel.

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<sup>53</sup> Unless SO<sub>x</sub> emission controlled by secondary means which at present is not clear.

## **V. Demonstrating Compliance**

### **A. Overview of Certification**

#### **1. How would I certify my engines?**

We are proposing to base certification data and administration requirements for new Category 3 marine engines on the existing program for Category 1 and Category 2 marine engines. These provisions are contained in 40 CFR part 94, and were described in detail in the preamble to the FRM that promulgated those regulations (64 FR 73300, December 29, 1999). In general, these provisions require that a manufacturer do the following things to certify engines:

- Divide engines into groups of engines with similar emission characteristics. These groups are called "engine families".
- Test the highest emitting engine configuration within the family.
- Determine deterioration rate for emissions and apply it to the "zero-hour" emission rate. The deterioration rate is essentially the difference between the emissions of the engine when produced and the point at which it would need to be rebuilt.
- Determine the emission-related maintenance that will be necessary to keep the engines in compliance with the standards.
- Submit the test data to EPA along with other information describing the engines within the engine family. This submission is called the "application for certification".

The certification provisions proposed for new Category 3 engines are discussed more fully in later sections. You should also read the proposed regulatory text, and the existing Category 2 regulations in 40 CFR part 94. These later section highlight the differences that we are proposing to apply to Category 3.

#### **2. How is the proposed certification method different from that used under Annex VI?**

In general, the two methods are similar. Our certification process is similar to the Annex VI pre-certification process, while our production-line testing program (described later) is similar to the Annex VI initial certification survey. However, the Clean Air Act specifies certain requirements for our certification program that are different from the Annex VI requirements. The most important differences between the proposed approach and the method used under Annex VI are related to witness testing (we allow, but do not require witness testing), the durability requirements, and test procedures. Our proposed durability requirements and testing requirements are discussed in other sections. It is also worth noting that, as described in Section III, we are proposing to apply the standards based on the date of final assembly of the engine, while Annex VI generally applies the standards based on the start-date of the manufacture of the vessel (i.e., the date on which the keel is laid), which would generally occur prior to the final assembly of the engine. Overall, we believe that our proposed regulations are sufficiently consistent with Annex VI that manufacturers would be able to use a single harmonized

compliance strategy to certify under both systems. The relationship between our proposed program and the Annex VI requirements is described in more detail in section V.D.

3. How does a certificate of conformity relate to a Statement of Voluntary Compliance or an EIAPP?

The Clean Air Act requires that manufacturers obtain a certificate of conformity before they introduce a new engine into commerce. Once it goes into force, MARPOL ANNEX VI will require manufacturers to obtain an "Engine International Air Pollution Prevention Certificate" (EIAPP). We anticipate that engines that receive an EPA certificate of conformity will also be eligible for an Engine International Air Pollution Prevention Certificate, since the proposed Tier 1 emission limits are the same as the Annex VI NO<sub>x</sub> limits and the Tier 2 limits under consideration are more stringent.

It should be noted that EIAPPs will not be issued until the Annex goes into force and can be issued only by the flag state Administration. Prior to entry into force of the Annex, and to encourage vessel owners to purchase MARPOL Annex VI compliant engines, we have developed a voluntary certification program. Under this program, the engine manufacturer can apply for and obtain a Statement of Voluntary Compliance to the MARPOL Annex VI NO<sub>x</sub> limits.<sup>54</sup> It is anticipated that ship owners will be able to exchange this Statement of Voluntary Compliance for an EIAPP after the Annex enters into force. If a shipowner does not have a valid Statement of Voluntary Compliance for an engine, it may be necessary to recertify the engine to obtain an EIAPP after the Annex enters into force. Finally, it should be noted that to obtain an EIAPP in this way, the Statement of Voluntary Compliance must be issued by EPA. A shipowner with a Statement of Voluntary Compliance issued by another Administration will have to apply for certification to obtain an EIAPP.

4. Could I use a continuous emission monitoring system to demonstrate compliance for certification?

You would generally not be able to use a continuous emission monitoring system to generate emission data that would be sufficient for our certification purposes. However, as we describe later, such a system could probably be used for production line testing or for in-use verification.

5. What would the roles of the engine manufacturer and ship owner be after the engine is installed?

Unlike the provisions of MARPOL Annex VI, under our proposed regulations, the engine manufacturer would have some responsibilities for in-use compliance. The manufacturer would be required to demonstrate that its engine would be capable of complying with the standards through the "useful life" of the engine (as described below, the useful life would generally be the

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<sup>54</sup>Information on how to obtain a Statement of Voluntary Compliance can be found on our website, [www.epa.gov/otaq/marine.htm](http://www.epa.gov/otaq/marine.htm)

first rebuild cycle). The manufacturer would be responsible for remedying failures that occur during that period. The ship owner would be responsible for ensuring that all proper maintenance is performed during the entire service life of the engine. After Annex VI goes into force internationally, the ship owner would also be responsible for compliance with the provisions contained in the NOx Technical Code, including the recordkeeping requirements for the Record Book of Engine Parameters and the various survey requirements. EPA and Coast Guard will work together to develop procedures to verify onboard performance of Annex VI requirements, as Coast Guard has the general authority to carry out such procedures on vessels.

#### 6. How would engines on foreign-flagged vessels be certified?

We are asking for comment regarding whether EPA should regulate all engines installed in foreign-flagged vessels that will call at a U.S. port (Categories 1, 2, and 3). In general, we would apply the same compliance provisions to foreign-flagged vessels as we would to U.S.-flagged vessels. We do not believe that manufacturers or owners of foreign-flag vessels would face unique constraints compared with manufacturers and owners of U.S.-flag vessels. Thus, the compliance discussions in the section V would apply without regard to whether the standards ultimately apply only to U.S.-flag vessels or to all vessels calling on U.S. ports.

It is worth discussing, however, how engines on foreign-flagged vessels would be certified if we determined that it was appropriate to regulate them in the rule. If we extended our regulations to these engines, compliance could be demonstrated for certification in one of two ways. Both would require that an application be submitted to EPA. It would not be sufficient to have obtained a certificate from a country other than the U.S. The simplest way to obtain an EPA certificate would be for the ship manufacturer to install a certified engine during the construction of the ship. In this case, we would treat this engine in the same manner as engines installed on U.S.-flagged vessels. Our proposed regulations would already allow this. This approach would also work for replacement auxiliary engines. The ship owner would only be required to purchase a certified marine engine.

The second approach would be for the engine to be certified after it has been installed in a vessel that will call at a U.S. port, but before the vessel is within 175 nautical miles of the U.S. As with our requirements for newly manufactured engines, we would require that emission test data be submitted in an application for certification to demonstrate that the engine complies with our requirements. This could be done by either the engine manufacturer or the ship owner. We recognize that we may need to allow different certification procedures to be used in these special cases. In fact, our existing regulations for smaller marine engines include an allowance for EPA to establish special certification procedures for engines on imported vessels (94.222). We could modify this provision to allow these special certification procedures for foreign-flagged vessels subject to our standards irrespective of whether such vessels are considered to be imported.

It is also worth noting that any vessel subject to our standards that has one or more uncertified engines installed could be denied the right to enter a U.S. port, because the vessel would not be in compliance with U.S. law. Similarly, a vessel with an engine that has within 175 nautical miles of the U.S. coastline operated outside the range of operating parameters within



which the engine is certified to comply with the applicable emission standard could be denied the right to enter a U.S. port. In addition, EPA could bring an enforcement action against the vessel and its operator under the Clean Air Act for injunctive relief and for penalties of up to \$27,500 for each day that a violation occurs. As is described in section III.C.3, if we were to apply our proposed standards to foreign-flagged vessels, we would consider exemption provisions to allow vessels with uncertified engines to make occasional, but not frequent visits to U.S. ports.

## **B. Other Certification and Compliance Issues**

### **1. How are engine families defined?**

We are proposing that engine grouping for the purpose of certification be accomplished through the application of an "engine family" definition. Engines expected to have similar emission characteristics throughout their useful life are proposed to be classified in the same engine family. We are proposing to define engine families consistent with MARPOL. To provide for administrative flexibility in the proposal, we would have the authority to separate engines normally grouped together or to combine engines normally grouped separately based upon a manufacturer's request substantiated with an evaluation of emission characteristics over the engine's useful life. We are requesting comment on the proposed requirements for selecting engine families. Do the proposed criteria provide sufficient certainty that NO<sub>x</sub> emissions would be similar for all of the engines within a particular family?

### **2. Which engines would be tested?**

We are proposing that manufacturers select the highest emitting-engine (i.e., "worst-case" engine) in a family for certification testing. This is consistent with the Annex VI requirements. In making that determination, the manufacturer shall use good engineering judgement (considering, for example, all engine configurations and power ratings within the engine family and the range of installation options allowed). By requiring the worst-case engine to be tested, we are assured that all engines within the engine family are complying with emission standards for the smallest number of test engines. If manufacturers believe that the engine family is grouped too broadly, they may request separating engines with dissimilar calibrations (based on an evaluation of emission characteristics over the engine's useful life) into separate engine families.

For these large marine engines, conventional emission testing on a dynamometer becomes more difficult. Often the engine mock-ups that are used for the development of these engines use a single block for many years, while the power assemblies are changed out. We propose that for Category 3 engines, certification tests may be performed on these engine mock-ups, provided that their configuration is the same as that of the production engines. In addition, we are proposing to allow single-cylinder tests, since a single-cylinder test should give the same brake-specific emission results as a full engine test, as long as each cylinder in an engine is equivalent in all material respects.

We are also proposing that manufacturers be required to allow EPA to perform confirmatory

testing using their certification engines. In other rules, we have required manufacturers to provide us with actual engines for our confirmatory testing program. However, this would not be practical for Category 3 engines because of their size and cost.

### 3. How does EPA treat adjustable parameters?

Diesel engines are often designed with adjustable components. For example, it is common to be able to adjust the fuel injection timing of an engine. EPA has historically required that these important adjustable parameters be physically limited to the range over which an engine would comply with the standards. Thus, while an uncontrolled diesel engine would typically have a broad (or even unlimited) range of adjustability, EPA-certified engines have a very narrow range of adjustability. Typically, this narrow range is enforced through physical stops on the adjustable parts. In some cases, manufacturers seal a component after final assembly to prevent any adjustment in use. Disabling physical stops, breaking seals, or otherwise adjusting an engine outside of the certified range is considered tampering with the emission controls, and is a violation of section 203(a) of the Clean Air Act.

For marine engines, broad adjustability allows engines to be adjusted for maximum efficiency when used in a particular application. This practice simplifies marine diesel engine production, since the same basic engine can be used in many applications. While we recognize the need for this practice, we are also concerned that the engine meet the proposed emission limits throughout the range of adjustment. Therefore, the Agency has established provisions for Category 2 engines to allow manufacturers to specify in their applications for certification the range of adjustment for these components across which the engine is certified to comply with the applicable emission standards, and demonstrate compliance only across that range. We are proposing to also allow such adjustments for Category 3 engines. Practically, this requirement means that a manufacturer would specify different fuel injection timing calibrations for different conditions. These different calibrations would be designed to account for differences in fuel quality, which can be very significant for Category three engines. Operators would then be prohibited by the anti-tampering provisions from adjusting engines to a calibration different from the calibration specified by the manufacturer. (See section V.B.10 for a discussion of adjustments away from the U.S.) Annex VI also allows engines to be adjusted in use, and requires the engine manufacturer to include a description of the allowable adjustments in the Technical File for the engine.

Given the broad range of ignition properties for in-use residual fuels, we expect that this allowance for Category 3 engines would result in a broader range of adjustment than is expected for Category 2 engines. Because of this broader allowance, we are also proposing that operators be required to perform a simple field measurement test to confirm emissions after a parameter adjustment or maintenance operation. This would not be required for adjustments or maintenance that would not affect emissions. In addition, given the degree to which Category 3 engines regularly undergo major maintenance (e.g., replacement of an entire power assembly), we believe that all Category 3 engines as a class should be considered to be inherently adjustable. We do not believe that a manufacturer could make an engine that would be unadjustable in practice. Therefore, we are proposing that all new Category 3 engines be equipped with emission

measurement systems and with electronic-logging equipment that automatically records all adjustments to the engine and the results of the required verification tests. EPA believes this is a nominal burden. We request comment on this proposed requirement. It is important to emphasize that we believe that it is essential that the logging equipment automatically record all adjustments without requiring the operator to turn on the data logger. (As is described in section V.B.10, this requirement would apply to all adjustments without regard to whether they occur within 175 nautical miles of the U.S. coast.) This would allow us to rely on the data log to ensure that the vessel is consistently being adjusted properly. We would also require that such adjustments be manually recorded as well, consistent with Annex VI requirements.

We are proposing to use a simpler measurement system than the type specified in Chapter 6 of NOx Technical Code. As is described in the RSD, we believe that onboard emission equipment that is relatively inexpensive and easy to use could be used to verify that an engine is properly adjusted and is operating to the specifications of the engine manufacturer. We do not believe that it would be necessary to perform a complete certification-type emission test after each adjustment. Under the proposed approach, operators should be able to complete this testing during normal operation without stopping or slowing the vessel. We also expect that this equipment will provide useful information to the ship's crew, that will enable them to better monitor the engine performance from a non-emission perspective. We believe that the proposed requirement to include this equipment should result in little or no net burden to ship operators. It is worth noting the fact that Annex includes specifications that would allow operators to choose to verify emissions through onboard testing suggests that MARPOL also envisioned that onboard measurement systems could be of value to operators.

We are requesting comment on the broader Annex VI approach to address engine adjustments, which is to specify that ship operators must keep the engine adjusted within the limits specified by the engine manufacturer and to verify the compliance through periodic surveys. Ship operators would have the choice between verifying the emissions performance through parameter check or through onboard testing. Commenters should address the reliability of this approach. We have concerns that the Annex VI parameter check approach could be difficult to enforce, since operators that adjusted their engines outside of a manufacturers specifications would have no incentive to record such violations. It is also not clear that a parameter check could be reliable, given the infrequency with which these surveys will likely occur. Commenters should address both the parameter check method and the testing method. Are they equivalent? Is the reliability of the testing method affected by whether the tests are scheduled in advance or are performed as part of a surprise inspection? Are surprise test inspections practical?

We also have concerns that, under the Annex VI approach, manufacturers would not be able to identify the specific adjustments that would be required for the full range of in-use conditions. While it is known that changes in fuel properties can require changes in engine calibrations, the properties themselves are poorly understood. We do not believe that manufacturers could specify to the operator that if fuel property A is equal to X, fuel property B is equal to Y, and fuel property C is equal to Z, then the fuel injection timing should be adjusted to a specific setting to make sure that the engine meets the emission standards. Not every important fuel property is

readily quantifiable, and different fuel properties can interact to affect performance. How would an operator record that a parameter was properly adjusted for a given in-use fuel if not all of the relevant fuel properties are quantifiable?

We also request comments on other approaches to ensure that engines with adjustable parameters meet the proposed emission requirements. Should we require that engine manufacturers design their engines to be automatically adjusted for changes in fuel quality of other conditions and prohibit all other adjustments? Would such a prohibition be practicable? We are also requesting comment on the need for and the feasibility of indicators on the outside of the vessel (e.g. a light) to indicate whether the pollution controls are working properly. Obviously, such a feature would need to be hard-wired into the vessel controls to be reliable.

#### 4. How would engines be labeled?

We are proposing that each new engine have a permanent emission label on the engine block, or on some other part of the engine that would not be replaced in service. This label would have to include specific emission-related information such as engine family name, model year, and basic maintenance specifications. This inclusion of this information on the label would be in addition to the recordkeeping requirements specified in the NOx technical code.

#### 5. How does EPA ensure durable emission controls?

To achieve the full benefit of the emissions standards, we need to ensure that manufacturers design and build their engines with durable emission controls. It is also necessary to encourage the proper maintenance and repair of engines throughout their lifetime. The goal is for engines to maintain good emission performance throughout their in-use operation. Therefore, we believe it is necessary to adopt measures to address concerns about possible in-use emission performance degradation. The proposed durability provisions, described in the following sections, are intended to help ensure that engines are still meeting applicable standards in use. Most of these provisions are carried over from our program for smaller marine compression-ignition engines. We request comment on all aspects of this durability program.

The most fundamental issue related to durability is the concept of useful life. The Clean Air Act specifies that useful life is the period during which an engine is required to meet the emission standards. For Category 3 marine engines subject to our standards, we are proposing that the useful life be the period during which an engine is expected to be properly functioning with respect to reliability and fuel consumption without being rebuilt. For engines that are rebuilt completely at one time, the useful life would be the expected period between original manufacture and the first engine rebuild. For engines that are maintained by replacing individual power assemblies, the useful life would be the expected period between original manufacture and the point at which the last power assembly is replaced. We expect that this period will vary to some degree among engine models. Therefore, we are proposing that manufacturers specify the useful life for their engines at the time of certification. Their specification would be subject to EPA approval, and could not be less than a minimum period of 3 years or 10,000 hours of operation (based on all engine operation, not just operation in or near U.S. waters). This

specification would not limit in-use operation. Rather it would determine how the manufacturer would address emission deterioration (i.e., the manufacturer would be required to demonstrate to EPA that the engine would meet the standards for the full useful life). We are also proposing that the useful life period may not be less than any mechanical warranty that the manufacturer offers for the engine.

These minimum useful life values are lower than the minimum values for Category 2 engines due to the effect of using residual fuel, which generally has much higher sulfur levels than distillate fuels. The high sulfur levels create a more corrosive environment within the combustion chamber, which decreases durability. The period of years (three years) is also affected by the higher usage rate in terms of hours per year. We request comment on this issue.

#### 6. What are the manufacturer's responsibilities for warranty and defect reporting?

Tied to the useful life is the minimum period for the warranty required under section 207(a) of the Clean Air Act. We believe it is important to ensure that the engine manufacturer has designed and built the engine to ensure that it would comply with the emission standards throughout its useful life, as long as it is properly maintained. Therefore, we are proposing that the warranty period be equal to the useful life period (e.g., 10,000 hours or 3 years). Under the performance warranty, the engine manufacturer would be responsible to repair any properly maintained and used engine that fails to meet the standard in use during the warranty period. (Engine operators would be responsible to repair any engines that failed to meet the standards because of improper maintenance.) We request comment on this approach.

We are also proposing defect-reporting requirements. These provisions require Category 3 engine manufacturers to report to EPA whenever a manufacturer identifies a specific emission-related defect in 2 or more engines (or 2 or more cylinders within the same engine). In most cases, we would expect the defects to be identified as part of a manufacturer's warranty process. However, the manufacturer would be required to report all defects, without regard to how they were identified. It is important to clarify that the defect reporting requirements would not require the manufacturer to collect new information. The manufacturer would be required to track and report to EPA information that they obtain through normal business practice. We request comment on this issue.

#### 7. What are deterioration factors?

To further ensure that the proposed emission limits are met in use, we are proposing to require the application of a deterioration factor (DF) to engines in evaluating emission control performance during the certification and production-line testing process. The emissions from new engines are adjusted using the DF to account for potential deterioration in emissions over the life of the engine due to aging of emission control technologies or devices. The resulting emission level is intended to represent the expected emissions at the end of the useful life period for a properly maintained engine. We believe that the effectiveness of some emission control technologies, such as aftertreatment, sophisticated fuel-delivery controls, and some cooling systems, can decline as these systems age. The DF is applied to the certification emission test

data to represent emissions at the end of the useful life of the engine. We are proposing that marine diesel engine DFs be determined by engine manufacturers in accordance with good engineering practices. The DFs, however, would be subject to EPA approval, and must be consistent with in-use test data. For example, if we had in-use test data from earlier model year engines from the same basic engine family that showed that NO<sub>x</sub> emissions generally deteriorate by 0.5 g/kW-hr over the useful life, then we would approve a DF that assumed no deterioration in NO<sub>x</sub> emissions. Additionally, the DF should be calculated for the worst-case engine configuration offered within the engine family.

It is not our intent to require a great deal of data gathering on engines that use established technology for which the manufacturers have the experience to develop appropriate DFs. New DF testing may not be needed where sufficient data already exists. However, we are proposing to apply the DF requirement to all engines so that we can be sure that reasonable methods are being used to ascertain the capability of engines to meet standards throughout their useful lives. Consistent with other programs, we propose to allow manufacturers the flexibility of using durability emission data from a single engine that has been certified to the same or more stringent standard for which all of the data applicable for certification has been submitted. In addition, we request comment on whether this flexibility should be extended to allow deterioration data from highway, nonroad, or stationary engines to be used for similar marine diesel engines.

Finally, we are proposing that DFs be calculated as an additive value (i.e., the arithmetic difference between the emission level at full useful life and the emission level at the test point) for engines without exhaust aftertreatment devices. In contrast, DFs should be calculated as a multiplicative value (i.e., the ratio of the emission level at full useful life to the emission level at the test point) for engines using exhaust aftertreatment devices. This is consistent with the DF requirements applicable to other diesel engines, based on observed patterns of emission deterioration. Given the type of emission controls projected to be used to meet the proposed standards (calibration changes and combustion chamber redesign, but not aftertreatment), it is possible that NO<sub>x</sub> emissions may actually decrease with time as the piston rings and cylinder liners wear (thereby reducing peak pressures). In such cases, we would require that the manufacturer use an additive DF of zero.

It is important to note that one of the reasons we are proposing a very flexible DF program for this rulemaking because we do not expect deterioration to be a major problem for these engines. Our history with in-cylinder NO<sub>x</sub> control suggests that engine-out NO<sub>x</sub> emissions are relatively stable over time. If we were to adopt an aftertreatment-forcing standard or a standard for PM, we would likely consider more specific requirements for calculating DFs. For example, it might be appropriate to apply to these engines the more specific DF provisions that have been developed for on-highway heavy-duty engines (40 CFR 86.004-26). Commenters that favor the adoption of an aftertreatment-forcing standard or a standard for PM should address whether they believe that the proposed DF program would be sufficient to ensure that manufacturers design their aftertreatment devices to be durable.

8. What requirements are proposed for in-use maintenance?

In previous rules, we have required manufacturers to furnish the ultimate purchaser of each new nonroad engine with written instructions for the maintenance needed to ensure proper functioning of the emission control system. (Generally, manufacturers require the owners to perform this maintenance as a condition of their emission warranties.) If such required maintenance is not performed by the engine operator, then in-use emissions deterioration can result. We are proposing to require that Category 3 engine operators be required to perform this maintenance, or equivalent maintenance. This provision is comparable to our requirement for railroads to perform emission-related maintenance for locomotives (40 CFR 92.1004). In that approach, locomotive owners who fail to properly maintain a locomotive are subject to civil penalties for tampering. For marine engines, properly rebuilding engines and power assemblies would be considered to be a part of emission related maintenance. We believe that these requirements would generally be consistent in practice with the provisions specified for ship operators in Technical File required by the NOx Technical Code.

An important part of this proposal is the allowance for operators to perform the maintenance differently than specified by the manufacturer, provided that maintenance is performed in such a way to keep the engines performing properly with respect to emissions. With the proposed emission verification requirements, it would be straightforward for ship operators to determine if their maintenance practices are sufficient. As long as their engines pass the verification tests, EPA would consider the maintenance to be equivalent. For ships that travel far from U.S. waters, this requirement would mean that maintenance would need to be performed in such a way that the engines would pass the verification tests before they come within 175 nautical miles of the U.S. coastline. (See section V.B.10 for more information about special provisions that apply for ships that travel more than 175 nautical miles from the U.S.)

Unlike our regulation for smaller marine engines, we are not proposing minimum allowable maintenance intervals for Category 3 marine diesel engines. This is also consistent with our approach for locomotives. In both cases, we believe that maintenance would be jointly agreed to by the engine manufacturer and the engine owner prior to purchase.

We are requesting comment on whether we should allow a manufacturer or owner to petition EPA to amend the emission-related maintenance instructions after the engine is in use, either within or after the useful life. This may be necessary because of the very long service lives of these engines. It may not be reasonable for us to require an owner of a 20-year old engine to be bound to maintenance practices that were set 20 years earlier. We are requesting comment on how such amendments would be made.

9. Do the proposed regulations affect engine rebuilding?

We are proposing in-use maintenance provisions that would require operators to perform emission related maintenance properly. We are proposing that this would also apply whenever an engine or engine subsystem is rebuilt. These provisions would require that all rebuilds return the engine to its original certified condition. (Failure to rebuild an engine to its original certified

condition would be considered tampering with the emission controls.) We believe that the proposed provisions would address the vast majority of in-use maintenance and rebuilding practices. However, we are concerned about special circumstances in which an owner wants to upgrade the engine to be comparable to a newer configuration rather than simply returning it to its original configuration. Under Annex VI, such "substantial modifications" are allowed, but the owner is required to recertify the engine. Should we adopt a similar provision? We are also requesting comment on a voluntary rebuild standard for older ships with engines that are not subject to our standards or the Annex VI requirements. For example, should we create a program for owners of ships built before 2004 to voluntarily certify that they comply with the EPA standards for model year 2004 ships?

As described in the previous section, for ships that travel far from the U.S., the proposed in-use maintenance provisions that would require operators to perform emission related maintenance so that an engine meets the manufacturer's maintenance requirements when it is within 175 nautical miles of the United States. For rebuilds performed away from the U.S., this would require that all rebuilds be performed so that the engine could be returned to its original certified condition before the ship returns to within 175 nautical miles of the United States. (See section V.B.10 for more information about special provisions that apply for ships that travel more than 175 nautical miles from the U.S.)

#### 10. Compliance with a certificate of conformity beyond 175 nautical miles of the U.S. coast

As described in section V.B.3, we are proposing to allow engines to be adjusted in use in accordance with the certificate of conformity, and to limit this adjustability under our Clean Air Act authority to prohibit tampering. We are also proposing different compliance requirements than those adopted in prior rulemakings for new nonroad vehicles and new nonroad engines for Category 3 marine engines installed in vessels that operate outside the U.S. Under this approach a vessel operator would be conditionally allowed to adjust an engine's operating parameters different from the manufacturer's specification. This would be allowed when a vessel that is proceeding toward or out of a U.S. port is more than 175 nautical miles about (200 statutory miles) from the U.S. coastline. More precisely, we would allow this for vessels that are more than 175 nautical miles from the baseline from which the territorial sea is measured, including U.S. states or territories outside of the U.S. mainland.

This flexibility is not included in the Annex VI provisions. While we considered proposing our program without this flexibility, we believe that it is an appropriate flexibility, as is described below.

Under the proposed approach, engine adjustments different from engine manufacturer's specifications would be conditional on readjusting the engine's parameters within its certified range and confirming that emissions are within the range of emissions to which the engine is certified to comply before a vessel seeking to enter a U.S. port is 175 nautical miles from the U.S. coastline. Failure to take these actions would constitute tampering with the engine in violation of section 203(a)(3)(A) of the CAA and 40 CFR 94.1103(a)(3)(i). To confirm that emissions are within the range of emissions at which the engine is certified to comply, operators



would have to perform a simple field measurement test after each parameter adjustment or maintenance operation that could reasonably be expected to affect emissions. (All adjustments and maintenance would be presumed to affect emissions unless there was a reasonable technical basis for believing that they did not affect emissions.) Furthermore, we would require that all new Category 3 engines be equipped with electronic-logging equipment that automatically records all adjustments to the engine and the results of the required verification tests. The logging equipment would be required automatically record all adjustments without requiring the operator to turn on the data logger, without regard to whether they occur within 175 nautical miles of the U.S. coast. It would not be possible to rely on the data log to ensure that the vessel is consistently being adjusted properly if the operator could turn the logger on and off. Since the logging would occur automatically, we do not believe there would be a significant burden to the operator. Such adjustments would also have to be manually recorded as well. Obviously, we would not allow adjustments that damaged the engine or its emissions controls or otherwise prevented the engine from being able to comply with our regulations after the readjustment.

Prior rulemakings that establish emission standards for new nonroad engines and vehicles prohibit anyone from disabling or otherwise tampering with an engine or vehicle that is covered by a certificate of conformity. See for example 40 CFR 94.1103(a)(3)(i). Our normal practice has been to require an engine to meet the emission standards at all specifications within an adjustable range. In addition, we normally require an engine manufacturer to make an engine's parameters unadjustable outside the range at which an engine is certified. We have adopted these practices to minimize the possibility that a certified engine can be intentionally or unintentionally adjusted to exceed the emission levels at which it is certified. If we take a different approach and allow Category 3 marine engines to conditionally allow a vessel operator to adjust an engine's operating parameters outside the range of specifications within which the engine is certified to comply with the applicable emission standards, we would be increasing the possibility that a certified engine would exceed the emission levels at which it is certified when it is in or near the United States. We are, nonetheless, proposing such an approach because of the unique issues associated with Category 3 marine engines that are installed in a vessel. These engines spend much of their time in international waters far away from U.S. coastal regions, where their emissions would have little or no effect on U.S. air quality. Tailoring the scope of the prohibition against tampering with a certified engine would allow vessel operators to readjust their engines for different performance characteristics in international waters when their emissions do not affect the U.S.

Although section 203(a)(3)(A) of the CAA prohibits the disabling of or tampering with emission control technology on a compliant motor vehicle or motor vehicle engine, there is no express statutory prohibition on such conduct with respect to new nonroad engines or vehicles. Although section 213(d) does provide that emission standards for new nonroad engines and vehicles "shall be enforced in the same manner" as standards prescribed for new motor vehicles and new motor vehicle engines, it is unclear whether this means "exactly equivalent" enforcement requirements or "analogous, comparable or consistent" enforcement requirements. The CAA, therefore, is ambiguous as to how emission standards for new nonroad engines and vehicles should be enforced.

We believe that it would be reasonable to interpret section 213(d) to allow the Agency to fashion enforcement provisions for new nonroad engines and vehicles that are consistent with, but not necessarily equivalent to, those applicable to new motor vehicles and new motor vehicle engines. Such an interpretation is consistent with the rest of section 213(d), which recognizes the need for different solutions to implement emission standards for new nonroad engines and vehicles. Specifically, section 213(d) provides that emission standards for nonroad engines and vehicles like emissions standards for new motor vehicles and new motor vehicle engines are subject to sections 206, 207, 208 and 209 “with such modifications of the applicable regulations implementing such sections as the Administrator deems appropriate.”

In this case, the need for a different solution than the one that we have traditionally adopted is warranted by the fact that the engines we propose to regulate operate primarily outside of the United States. As discussed above, marine Category 3 engines installed in vessels spend much of their time in waters far away from U.S. coastal regions, where their emissions would have little or no effect on U.S. air quality. Enforcing emission standards for these kinds of engines, therefore, is different than enforcing standards for motor vehicles and motor vehicle engines that operate primarily, if not exclusively, inside the United States. However, vessel operators that adjust an engine’s operating parameters outside the range within which the engine is certified to comply with the applicable emission standards, would have to readjust the engine’s parameters to its certified calibration and confirm that emissions are within the range of emissions to which the engine is certified to comply before a vessel seeking to enter a U.S. port is 175 nautical miles from the U.S. coastline.

As described in previous sections, we are proposing to apply this same approach for engine maintenance and rebuilding. Within 175 nautical miles of the U.S., improper maintenance or rebuilding of an engine would be considered to be tampering to the extent that it compromised the emission performance of the engine. On the other hand, engine maintenance and rebuilding that occurs more than 175 nautical miles away from the U.S. would be treated as any other type of emission-related adjustment. Ship operators could maintain or rebuild the engine however they would choose, provided that the engine is returned to a certified configuration and passes the emission verification test specified in 94.1003(b) of the proposed regulations before it comes within 175 nautical miles of the U.S.

We are proposing this limit of 175 nautical miles to control Category 3 emissions that affect U.S. air quality, especially emissions from coastwise traffic. As described in the draft RSD, we believe that the emissions that occur within 175 nautical miles (200 statutory miles) of the U.S. coastline represent a significant fraction of the total inventory and that these emissions can significantly affect U.S. air quality. Assuming a 10 mile per hour wind blowing toward the coast, these emissions would reach the coast in less than one day. Setting this threshold at some shorter distance would not adequately account for these emissions. We considered proposing a larger distance. The Ozone Transport Assessment Group<sup>55</sup> has estimated that within the continental U.S., emissions can affect air quality as far away as 500 statutory miles from the emission source.

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<sup>55</sup> Final Report of the Ozone Transport Assessment Group, Chapter 4.

Other analyses have suggested that NO<sub>x</sub> and SO<sub>x</sub> emissions could be transported even farther than that. However, there is uncertainty associated with the transport of ship emissions. Most transport studies have focused on transport that occurs over land, and emissions over the ocean do not have the same effect as land-based emissions due to different meteorological conditions. While we recognize that some emissions that occur beyond 175 nautical miles could potentially affect U.S. air quality, these effects are hard to quantify. At this time, we cannot determine that emissions beyond 175 nautical miles would have a significant effect in most cases.

We will continue to investigate this issue throughout this rulemaking, and will incorporate any new information into the final rule. For example, the Department of Defense (DoD) has recently presented information to EPA supporting the significance of offshore emissions, but suggesting that a different, shorter (offshore distance) limit may be appropriate to address the emissions from marine vessels that would affect on-shore air quality. DoD's extensive work on the marine vessels issue in Southern California resulted in a conclusion that emissions within 60 nautical miles of shore could make it back to the coast due to eddies and the nature of the sea breeze effects. Their analysis of satellite data, however, showed a distinct tendency for a curved line of demarcation separating the offshore (unobstructed) or parallel ocean wind flow from a region of more turbulent, recirculated air which would impact on-shore areas. That curved line of demarcation was close to San Nicolas Island which is about 60 nm offshore from the California coast. DoD also indicated that studies and published information on other coastal areas in California indicate that they experience somewhat narrower (perhaps 30 nm ) region of "coastal influence". We are investigating how this information would related to other coastal regions such as the Gulf Coast and the East coast, which would be expected to have their own unique meteorological conditions that might call for different lines of demarcation between on-shore and off-shore effects.

We believe that the proposed distance would protect U.S. air quality without placing an undue burden on ship operators. Nevertheless, we request comment on the proposed distance. We encourage commenters to address both the long-distance effect of marine engine emissions on U.S. air quality and the potential impact of this proposed approach on ship operations. We are requesting comment regarding the appropriateness of applying a single distance to all coastal regions, without considering prevailing wind patterns. For example, would it be more appropriate to set a larger distance for the Pacific coast and a smaller distance for the Atlantic coast? Would such an approach be practical? We are also requesting comment on whether we should treat the waters around U.S. island territories such as Guam in the same way that we treat the coastal waters around the continental U.S. Would emissions around these islands affect their air quality to the same extent as coastal emissions around the U.S. mainland? Alternatively, we could exempt the island territories from these requirements, pursuant to section 324(a) of the Act, if petitioned by the governors of the territories.

Finally, it is worth noting that since we expect that manufacturers would design their engines to have good performance when adjusted to their compliant calibrations, it should not make a major difference to operators exactly where they conduct the verification test. Therefore, we would expect that operators that adjust their engines outside of the manufacturer's recommended range would begin readjusting their engines when they reach the 200-mile EEZ

limit. This would allow them to adjust their engines and complete the verification test before they reached the proposed 175-mile limit. It would also provide time to readjust the engine if it were to fail the initial emission verification test. If we determine that some distance other than the proposed 175-mile limit would better divide those emissions that affect U.S. air quality from those emissions that do not, should we incorporate some additional cushion to ensure that operators would have sufficient time to readjust and retest an engine before its emissions could adversely affect U.S. air quality?

11. Are there proposed post-certification testing requirements?

To ensure compliance of production engines, we are proposing a simple testing program that is modeled loosely on our production line testing (PLT) requirements for other marine engines. The general object of any PLT program is to enable manufacturers and EPA to determine, with reasonable certainty, whether certification designs have been translated into production engines that meet applicable standards. We are not proposing a specific testing requirement, and would allow manufacturers flexibility in determining how to test the engines. However, we are proposing some minimum requirements. First, we would require that each certified engine that a manufacturer produces be tested. We would also require that either the test directly measure brake-specific emissions, or measure other parameters that provide equal assurance that each engine meets the standards. The testing would need to occur after final installation, but before final delivery to the ultimate purchaser. We would suspend the certificate of conformity for any failing engine, or if the engine manufacturer's submittal reveals that the tests were not performed in accordance with the applicable testing procedure. The manufacturer must then bring the engine into compliance before we could reinstate the certificate of conformity subsequent to a suspension. We would also suspend the certificate of conformity for an engine family whenever an engine fails. The manufacturer would need to identify and remedy the cause of the failure before we could reinstate the certificate of conformity for future production within that family. EPA will work with the U.S. Coast Guard to develop procedures to verify onboard performance of these field measurement provisions, as Coast Guard has the general authority to carry out such procedures on vessels..

12. What would the prohibited acts and related requirements be?

We are proposing to regulate Category 3 engines under 40 CFR part 94. This means that we are proposing to extend the general compliance provisions for smaller marine engines to Category 3 marine engines. These include the general prohibition introducing an uncertified engine into commerce, as well as the tampering and defeat-device prohibitions. However, as described in Section V(B)(10), we are proposing to modify the tampering provision for Category 3 engines to allow operation outside of the otherwise allowable range of adjustment when the vessel is far away from the U.S. All other aspects of the existing tampering prohibition would apply. These prohibitions are listed in 94.1103. EPA seeks comment on extending these provisions to Category 3 engines, and on any additional modifications that should be made to these provisions to accommodate special features of these engines.

13. Would there be general exemptions for engines?

We are proposing to extend the exemptions provisions for smaller marine engines to Category 3 marine engines. These include, for example, exemptions for the purpose of national security and exemptions for engines built in the U.S. for export to other countries. These exemptions, which are described in Subpart J of 40 CFR part 94, would exempt the engines from the proposed requirements, but would require that the manufacturer keep records or label the engines in some cases. Both the exemption and the related requirements are allowed under our general standard-setting authority.

14. What regulations would apply for imported engines?

We are proposing to extend the current importation provisions found in 40 CFR part 94 for smaller marine engines to Category 3 marine engines. This means that we are proposing that engines that are imported would generally be subject to the proposed requirements based on their date of original manufacture. The existing provisions for smaller engines include permanent and temporary exemptions from this requirement. The most significant of these import exemptions for ocean-going vessels is the allowance to temporarily import an engine for repair.

15. What would be a manufacturer's recall responsibilities?

Section 207(c)(1) of the Act specifies that manufacturers must recall and repair in-use engines if we determine that a substantial number of them do not comply with the regulations in use. We are proposing to apply the existing provisions for smaller marine engines to Category 3 marine engines. These provisions are described in Subpart H of 40 CFR part 94.

### **C. Test Procedures for Category 3 Marine Engines**

Engine manufacturers are currently testing according to the test procedures outlined in The Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines in the “Annex VI of MARPOL 73/78 Regulations for the Prevention of Air Pollution from Ships and NOx Technical Code” from the International Maritime Organization. We are proposing to certify Category 3 marine engines using these MARPOL test procedures for diesel marine engines with modification. The modifications, which are described in the following sections, are required to ensure that the test data used for certification are consistent with the requirements of the Clean Air Act.

1. What duty cycle would I use to test my engines?

The duty cycle used to measure emissions is intended to simulate operation in the field. Testing an engine for emissions consists of exercising it over a prescribed duty cycle of speeds and loads, typically using an engine dynamometer. The nature of the duty cycle used for determining compliance with emission standards during the certification process is critical in evaluating the likely emissions performance of engines designed to those standards.

To address operational differences between engines, we are proposing two different duty cycles for different types of C3 marine engines. Engines that operate on a fixed-pitch propeller curve would be certified using the International Standards Organization (ISO) E3 duty cycle. This is a four-mode steady-state cycle developed to represent in-use operation of marine diesel engines. The four modes lie on an average propeller curve based on the vessels surveyed in the development of this duty cycle. We are proposing ISO E2 for propulsion engines that operate at a constant speed. These are the cycles used by MARPOL.

## 2. What kind of fuel would be required for emission testing?

To facilitate the testing process, we generally specify a test fuel that is intended to be representative of in-use fuels. Engines would have to meet the standard on any fuel that meets the proposed test fuel specifications, with one modification as described later. This test fuel is to be used for all testing associated with the regulations proposed in this document, to include certification, production line and in-use testing.

We are proposing that the official test fuel specification for C3 engines be a residual fuel. We are proposing to allow a range of fuels based on the ASTM D 2069-91 specifications for residual fuel. We would allow testing using any residual fuel meeting the specifications for RMH-55 grade of fuel including fuels meeting the specifications for RMA-10 grade of fuel. We request comment on this specification. An alternative to this approach might be to narrowly define a worst-case test fuel. Your comments should address whether the grade of the test fuel would affect the feasibility or the stringency of the proposed standard. We also are requesting comment on whether there needs to be a specification for ignition properties of the test fuels, such as cetane.

This ASTM specification does not include any specification for the nitrogen content of the fuel. Organically-bound nitrogen is a normal component of residual fuels that has a very significant effect on NO<sub>x</sub> emissions. However, the effect on NO<sub>x</sub> can be calculated from the nitrogen content of the fuel. Therefore, we are proposing to include a broad specification for the nitrogen content of the fuel (between zero and 0.6 weight percent), and to require correction of the NO<sub>x</sub> emissions based on the nitrogen content of the fuel.

We are also proposing to allow certification testing on marine distillate fuel to be consistent with MARPOL testing (see section IV.A.2). However, distillate fuels tend to have lower nitrogen content than residual fuels. To account for this, we would correct the NO<sub>x</sub> emissions, based on fuel nitrogen content, to be equivalent to testing with residual fuels. We request comment on this approach. Your comments should address whether we should account for factors other than nitrogen content of the fuel in our correction.

Finally, based on our current understanding of the importance of fuel nitrogen levels, we are proposing to also establish a nitrogen-correction for testing Category 1 and Category 2 engines using residual fuel. This correction would be consistent with the Category 3 correction. However, since the Category 1 and Category 2 standards are based on zero-nitrogen fuel, the Category 1 and Category 2 correction would correct to 0.0 percent nitrogen instead of 0.4 percent

nitrogen for Category 3. In the Category 1 and Category 2 FRM, we intended to set the standards so that they could be achieved by Category 2 engines that use residual fuel. After reconsidering the effect of fuel nitrogen, we now believe that this correction is necessary to achieve that goal.

### 3. How would EPA account for variable test conditions?

We are not proposing to limit certification testing based on barometric pressure or ambient humidity. We are proposing to limit the allowable ambient air temperature to 13°C to 30°C and charge air cooling water to 17°C to 27°C. However, since a manufacturer would not always be able to stay within these ranges for tests conducted after the engine is installed in the ship, we are proposing to allow production testing and in-use testing under broader conditions. Engine manufacturers would need to provide information about how emissions are affected at other temperatures to allow production testing and in-use testing conducted under the broader conditions to be used to verify compliance with the emission standard.

We are proposing to use the MARPOL Annex VI correction factors for temperature and humidity for certification testing. We would allow the use of the corrections for a broader range of test conditions, provided the manufacturer verifies the accuracy of the correction factors outside of the range of test conditions for certification.

### 4. How does laboratory testing relate to actual in-use operation?

If done properly, laboratory testing can provide emission measurements that are the same as measurements taken from in-use operation. However, improper measurements may be unrepresentative of in-use operation. Therefore, we are proposing regulatory provisions to ensure that laboratory measurements accurately reflect in-use operation. In the proposed regulations, there is a general requirement that manufacturers must use good engineering judgment in applying the MARPOL Annex VI test procedures to ensure that the emission measurements accurately represent emissions performance from in-use engines. We are proposing specific requirements that the manufacturers ensure that intake air and exhaust restrictions and coolant and oil temperatures are consistent with in-use operation. Most importantly, we are proposing that manufacturers' simulation of charge-air cooling replicate the performance of in-use coolers within  $\pm 3^\circ\text{C}$ .

The definition of maximum test speed, (the maximum engine speed in revolutions per minute, or rpm) is an important aspect of the test cycles proposed in this document. Under Annex VI, engine manufacturers are allowed to declare the rated speeds for their engines, and to use those speeds as the maximum test speeds for emission testing. However, we are concerned that a manufacturer could declare a rated speed that is not representative of the in-use operating characteristics of its engine in order to influence the parameters under which their engines could be certified. Therefore, we are proposing to apply the current definition of "maximum test speed" in 94.107 to Category 3 engines that are subject to our standards.

5. What is required to perform a simplified onboard measurement?

We are proposing that simplified onboard measurements be used to confirm proper adjustment of in-use engines as described in sections V.B.3 and V.B.10. These systems must be capable of measuring NO<sub>x</sub> concentration, exhaust temperature, engine speed, and engine torque. Operators would compare the NO<sub>x</sub> concentration and exhaust temperature to limits provided by the manufacturer. Tests that showed emissions higher than allowed under the manufacturer's specifications would mean that the engine was not properly adjusted. If the engine was within 175 nautical miles of the U.S. coast, then this would require that the engine be readjusted and retested. Such exceedances 175 nautical miles of the U.S. coast would not be considered to be violations of the regulations, provided they were corrected immediately.

**D. Comparison to Annex VI Compliance Requirements**

1. Why are EPA's proposed compliance requirements different from the Annex VI requirements?

We have attempted to propose compliance requirements that are sufficiently consistent with Annex VI that manufacturers would be able to use a single harmonized compliance strategy to certify under both systems. However, the Clean Air Act specifies certain requirements for our compliance program that are different from the Annex VI requirements. The most important differences between the proposed approach and the method used under Annex VI are related to witness testing, the durability requirements, and test procedures. It is the durability requirements of the Clean Air Act that represent the most fundamental differences between the Annex VI certification program and the program required by the Clean Air Act. Section 213 of the Act requires that the engine manufacturer be responsible for ensuring compliance with the emission standards for the full useful life of the engine. The Annex VI certification provisions do not include this kind of requirement, and make the ship operators fully responsible for ensuring in-use compliance through periodic survey requirements. Thus, we cannot adopt the Annex VI certification and compliance requirements to implement the requirements of the Clean Air Act.

We believe that adopting certification provisions similar to our existing Category 1 and 2 requirements would best meet the requirements of the Clean Air Act.

2. What would be the most significant differences between the two programs?

There are a number of differences between the two programs. These differences are summarized below. They were also discussed in more detail in the earlier subsections of this section V.

- Liability for in-use compliance - We require that the engine manufacturer be responsible for ensuring compliance with the emission standards for the full useful life of the engine, while the Annex VI program makes the ship operators fully responsible for ensuring in-use compliance. Both our regulations and Annex VI provisions would require ship operators to properly maintain their engines and to keep records of the



maintenance and engine adjustment. Under Annex VI, these records are referred to as the Record Book of Engine Parameters.

- Durability demonstration - We require that the engine manufacturer demonstrate prior to production that they comply with the emission standards for the full useful life of the engine (see section V.B.5). The Annex VI program would only require that the manufacturer demonstrate that the engine meets the standards when it is installed in the vessel; there is no Annex VI durability demonstration.
- Witness testing - We allow, but do not require witness testing for U.S. compliance. Some other countries require witness testing for marine engines. Manufacturers would need to take this into consideration if they plan to sell the same engines in the U.S. and those other countries.
- Test procedures - We are proposing to certify Category 3 marine engines using the Annex VI test procedures for diesel marine engines with modification. The modifications, which are described section V.C, are required to ensure that the test data used for certification are representative of in-use operation. We expect that manufacturers would be able to use data from certification tests conducted according to the modified EPA procedures for Annex VI certification.
- Test fuel - As described in section V.C.2, we are proposing that the official test fuel specification for C3 engines be a residual fuel. Annex VI specifies using distillate test fuels and uses distillate testing as the basis of its standards. We are proposing to allow certification testing on marine distillate fuel to be consistent with Annex VI. However, we would correct the NO<sub>x</sub> emissions, based on fuel nitrogen content, before the test results are compared to our residual fuel based standards.
- Compliance date for standards - As described in Section III, we are proposing to apply the standards based on the date of final assembly of the engine, while Annex VI generally applies the standards based on the start-date of the manufacture of the vessel (i.e., the date on which the keel is laid). Since the laying of the keel would almost always occur prior to the final assembly of the engine, this provides manufacturers with somewhat more lead time than is provided by the Annex VI provision. Note that this difference would not matter for Tier 1, since the effective date of the Annex VI limits has already passed (January 1, 2000).
- Production testing - We are proposing a simple production testing program ensure that certification designs would be translated into production engines that meet applicable standards. We are not proposing a specific testing requirement, and would allow manufacturers flexibility in determining how to test the engines. Annex VI also requires verification that engines are properly installed, but allow this to be demonstrated by either a parameter check or by testing.
- Technical file - Annex VI requires that engine manufacturers provide operators with a

Technical File that contains maintenance instructions, test data, and other compliance information. We are proposing only to require the manufacturer to provide maintenance instructions necessary to ensure that the engine would continue to meet the emission standards in use.

- In-use compliance - To ensure that an engine in-use continues to meet the standards, we are proposing that operators be required to perform a simple field measurement test to confirm emissions after a parameter adjustment or maintenance operation. The Annex VI program would require only periodic surveys of the engine, which can take the form of a simplified onboard test or, more frequently, a parameter check. The parameter check can be as simple as reviewing the record book of engine parameters to see if any adjustments were made to the engine that were outside the range of acceptable parameter adjustments specified by the engine manufacturer. Both of these would be carried out by representatives of the flagging state.
- Parameter adjustment - We are proposing to allow manufacturers to specify in their applications for certification the range of adjustment across which the engine is certified to comply with the applicable emission standards. This would allow a manufacturer to specify different fuel injection timing calibrations for different conditions. These different calibrations would be designed to account for differences in fuel quality. Operators would then be prohibited by the anti-tampering provisions from adjusting engines to a calibration different from the calibration specified by the manufacturer when they are within 175 miles of the U.S. coast. We are also proposing to require all new Category 3 engines be equipped with emission measurement systems and with automatic electronic-logging equipment that automatically records all adjustments to the engine and the results of the required verification tests. (See sections V.B.3 and V.B.10 for more details.) Annex VI would prohibit operators from adjusting engines to a calibration different from the calibration specified by the manufacturer under any circumstances.
- Onboard measurement - We are proposing that simplified onboard measurements be used to confirm proper adjustment of in-use engines as described in sections V.B.3 and V.B.10. Annex VI allows such systems, but does not require them.

3. Could a manufacturer comply with both the EPA requirements and the Annex VI requirements at the same time?

A manufacturer that complied with the proposed EPA requirements would need to do very little additional work to meet the Annex VI requirements. First, the engine manufacturer would need to provide the operator with a Technical File that contains more information than would be required by EPA. The manufacturer may also need to ensure that the relevant emission testing is witnessed appropriately.

For manufacturers that have already complied with the Annex VI, the amount of additional work that would be required to comply with the proposed EPA requirements, would be dependent

on how the manufacturer conducted its emission testing. Annex VI allows manufacturers more discretion in testing engines than would be allowed under our proposed regulations, and does not necessarily require that the engine be tested fully consistent with in-use operation. Under the proposed regulations, tests of engines that are not consistent with in-use operation would not be allowed, unless the manufacturer could demonstrate that the test results were equivalent to test results that would result from testing conducted in accordance with the proposed regulations. In these cases, manufacturers would need to repeat the tests according to the proposed test procedures. On the other hand, manufacturers that used their good engineering judgment to test their engines consistent with their in-use operation would generally be allowed to use the same test data for EPA certification. For future testing, manufacturers would be able to test their engines in compliance with both the Annex VI procedures and the proposed EPA procedures.

With respect to the other proposed compliance requirements not related to certification testing, manufacturers would need to do the following things in addition to the Annex VI requirements:

- Demonstrate prior to production that the engines would comply with the emission standards for the useful life of the engine.
- Warrant to the purchasers that the engines would comply with the EPA requirements for the useful life of the engine.
- Perform a simple production test after installation.
- Install an onboard measurement system.
- Specify how the operator should adjust the engine in use and how proper adjustment should be verified through testing.

## **VI. Projected Impacts**

### **A. What are the anticipated economic impacts of the proposed standards?**

Our analysis of the projected impacts of the proposed standards consists primarily of estimating the costs, emission benefits, and cost per ton of pollutant reduced.

With regard to the proposed Tier 1 standards, we expect the costs of the proposed Tier 1 standards to be negligible. We do not anticipate that there will be any engineering or design costs associated with the Tier 1 standards because manufacturers are already certifying engines to the Annex VI standards through our voluntary certification program (see Section E.2 of the preamble for this rule). While there will be certification and compliance costs, these costs will be negligible on a per-engine basis. The emission reductions from the proposed Tier 1 standards will reflect only reductions from engines that are currently in noncompliance with the Annex VI NO<sub>x</sub> limits. For these reasons, the projected impacts of this rule are expected to be negligible.

Additionally, because the total annualized costs associated with complying the proposed rule are a small percentage of total market revenues, it is unlikely that market prices or production will change as a result of the proposed rule. Furthermore, the total annualized costs associated with applying the reductions to all vessels is smaller; thus, we would still not anticipate appreciable changes in market prices or quantities to be associated with the proposed rule.

The remainder of this section discusses the projected impacts of a second tier of standards currently under consideration that would reflect a 30 percent reduction from Tier 1.

**B. What are the anticipated economic impacts of the standards under consideration?**

As described below, aggregate annualized costs of adopting the Tier 2 standards discussed above are estimated to be about \$1.6 million per year. In assessing the economic impact of setting emission standards, we have made a best estimate of the combination of technologies that an engine manufacturer would most likely use to meet the new standards discussed in this Notice. The analysis presents estimated cost increases for new engines. These estimates include consideration of variable costs (for hardware and assembly time), fixed costs (for research and development, and retooling), and compliance costs (for certification testing and onboard emission measurements). The analysis also considers total operating costs, including maintenance and fuel consumption. Cost estimates based on these projected technology packages represent an expected change in the cost of engines as manufacturers begin to comply with new emission standards. All costs are presented in 2002 dollars. Full details of our cost analysis can be found in Chapter 5 of the Draft Regulatory Support Document.

Table VI.B-1 summarizes the projected costs for meeting the Tier 2 emission limits under consideration. Anticipated incremental new engine cost impacts of the Tier 2 emission limits discussed in this notice for the first years of production range from \$94,000 to \$153,000 per engine with an calculated composite cost of \$115,000. Long-term impacts on engine costs are expected to be lower, ranging from \$25,000 to \$63,000 per engine with a composite cost of \$39,000. Most of this cost reduction is accounted for by the fact that research, testing, and other fixed costs dominate the cost analysis, but disappear after the projected ten-year amortization period. Some additional cost reduction is expected to result from learning in production. We believe that manufacturers would be able to combine emission-control technologies to meet the Tier 2 emission standards under consideration without increasing fuel consumption or other operating costs. The cost analysis, however, includes an estimated \$5,000 of annual expenses to maintain equipment for onboard emission measurement, which corresponds with a net-present-value at the point of sale of \$61,000. See Chapter 5 of the Draft Regulatory Support Document for a more detailed discussion of the analysis to estimate the costs of emission-control technology for meeting a second tier of emission standards.

Table VI.B-1  
Summary of Projected Costs to Meet Tier 2 Emission Standards—U.S.-flag only

Time Frame	Medium-speed Engines			Slow-speed Engines		
	6 cyl.	9 cyl.	12 cyl.	4 cyl.	8 cyl.	12 cyl.
Total cost per engine (yr. 1)	\$93,587	\$98,977	\$104,368	\$106,414	\$129,723	\$153,031
Total cost per engine (yr. 6 and later)	\$25,452	\$28,902	\$32,352	\$33,661	\$48,579	\$63,496
Annual operating costs	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000

Table VI.B-2 shows the same cost estimates for the scenario of requiring engines on foreign-flag vessels to meet emission standards. Near-term costs are generally lower in this scenario because fixed costs can be amortized over substantially larger numbers of engines. The same manufacturers produce engine used in U.S. and foreign-flagged vessels. In addition, the majority of the vessels visiting the U.S. are foreign flagged. Therefore, we do not estimate separate costs for applying the Tier 2 standards to foreign flagged vessels only.

Table VI.B-2  
Summary of Projected Costs to Meet  
Tier 2 Emission Standards—Including Foreign-flag

Time Frame	Medium-speed Engines			Slow-speed Engines		
	8 cyl.	12 cyl.	16 cyl.	4 cyl.	8 cyl.	12 cyl.
Total cost per engine (yr. 1)	\$35,970	\$41,360	\$46,751	\$48,797	\$72,106	\$95,414
Total cost per engine (yr. 6 and later)	\$25,452	\$28,902	\$32,352	\$33,661	\$48,579	\$63,496
Annual operating costs	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000	\$5,000

The above analysis presents unit cost estimates for each power category. With current data for engine and vessel sales for each category and projections for the future, these costs can be translated into projected direct costs to the nation for the new emission standards in any year. Aggregate annualized costs (based on a 20-year stream) are estimated to be about \$1.6 million per year. This is based on the present value of an annuity discounted at 7 percent over a 20-year stream of costs. Aggregate annualized costs not including the NOx monitoring costs are estimated to be about \$1 million. Applying the Tier 2 emission standards described in this notice also to engines on foreign-flag vessels would increase aggregate annualized costs to about \$54 million. In both cases, estimated aggregate costs per year fall substantially after five years as manufacturers would no longer need to recover their amortized costs.

The annualized aggregate cost (no operating costs) of \$1 million represents 0.17 percent of total annual shipbuilding industry revenues based on the 1997 value of shipments. Because the total annualized costs associated with complying the Tier 2 standards under consideration are a small percentage of total market revenues, it is unlikely that market prices or production will change as a result of these proposed rules. Furthermore, the total annualized costs associated with applying the reductions to all vessels is smaller; thus, we would still not anticipate appreciable changes in market prices or quantities to be associated with the standards under consideration.

**C. What are the anticipated emission reductions of the standards under consideration ?**

The following discussion gives a brief overview of the methodology we used to determine the emissions reductions from Category 3 marine diesel engines associated with this proposed rule and alternatives we are considering. Chapter 6 of the Draft Regulatory Support Document provides a detailed explanation of the methodology and results. Section II of this preamble and Chapter 2 of the Draft Regulatory Support Document contain information about the health and welfare concerns associated with Category 3 marine diesel engine pollution.

To model the emission reductions of the standards discussed in this Notice we applied an engine replacement schedule and the emissions standards to the baseline inventory. We also accounted for the MARPOL Annex VI NOx limits. Although these standards are not yet effective, they are being largely complied with around the world, and we expect this trend to continue. Thus, we are using the Annex VI limits as the baseline for purposes of showing the expected emissions reductions from the Tier 2 standards. Thus, we are assuming that all U.S. and foreign flagged vessels built after 1999 will comply with the Annex VI limits, and show the benefits of the Tier 2 standards relative to this baseline. We are only considering that the Tier 2 standards apply to U.S. flagged vessels. Thus, we only applied the expected emissions reductions from the Tier 2 standards to the portion of the national inventory attributable to U.S. flagged vessels. Also, because the HC and CO standards are intended only to prevent future increases in HC and CO emissions, and because we are not considering PM standards, we are claiming no emissions reductions in HC, CO or PM. Table VI.C-1 shows our estimates of Category 3 vessel NOx emissions with and without the Tier 2 standards, as well as the impact of the MARPOL Annex VI NOx limits.

It is important to note that we only modeled the emissions reductions within 175 nautical miles of the U.S. coast. However, reductions from the Annex VI standards and the Tier 2 standards would also likely occur outside of 175 nautical miles of the U.S. coast. To the extent that vessels in compliance with these limits visit foreign ports some emissions reductions would likely be seen in those areas as well.

Table VI.C-1  
Category 3 Marine Vessel NOx National Emissions Inventories

		1996	2010	2020	2030
No control baseline (thousand short tons)		190	303	439	659
MARPOL Annex VI	(thousand short tons)	190	274	367	531
	Percent reduction (relative to no control)	—	9.6%	16.2%	19.5%
Tier 2	Control (thousand short tons)	190	269	343	475
	Percent reduction (relative to	—	2.0%	6.8%	10.5%

As discussed in Section III, we are only proposing to apply the emissions standards to U.S. flagged vessels. The effect of applying the Tier 2 standards to both U.S. and foreign flagged vessels is shown in Table VI.C-2. As can be seen from this table, the projected emissions reductions from applying a second tier of standards would be substantially greater in 2030 if foreign flagged vessels were also to comply with such limits. EPA believes this information provides support for pursuing an international agreement to limit emissions to such levels in the context of additional reductions under MARPOL.

Table VI.C-2  
Effect of Application of Tier 2 Emissions Standards Based on Vessel Flag  
(U.S. Flagged Vessels vs. All Vessels)

Scenario	2020		2030	
	NOx (1000 tons)	% reduction	NOx (1000 tons)	% reduction
Baseline (Annex VI)	367	--	531	--
U.S. Flagged Only	343	6.8%	475	10.5%
All Vessels	306	16.7%	392	26.1%

**D. What is the estimated cost per ton of pollutant reduced for this proposal and alternatives we are considering?**

We estimated the cost per ton of NOx reduction of the NOx emission standards discussed in this Notice. Chapter 7 of the Draft Regulatory Support Document contains a more detailed discussion of the cost per ton analysis. The calculated cost per ton of the proposed emission standard presented here includes all of the anticipated effects on costs and emission reductions.

1. Tier 1 cost per ton

The proposed Tier 1 standards are equivalent to the MARPOL Annex VI standards. Because engines already comply with the MARPOL Annex VI standards, we not claiming any benefits or costs to meet the EPA proposed Tier 1 standards.

2. Tier 2 cost per ton

To determine the cost per ton of NOx reduction associated with the Tier 2 emission standards discussed in section IV.A.3, we only considered emissions reductions beyond those achieved by the MARPOL Annex VI standards. Table VI.D-1 presents the cost per ton of the Tier 2 standards discussed in this notice for U.S. flagged Category 3 marine engines. By weighting the projected cost and emission benefit numbers presented above by the populations, we also calculated the aggregate cost per ton of NOx reduced for Category 3. The net present value (NPV) of the costs and emissions reductions shown here are discounted at a rate of 7

percent per year. For comparison, estimates are also presented here for applying these standards to foreign flagged vessels as well. These cost per ton estimates are higher because only emission reductions within 175 nautical miles of the U.S. coast are considered and foreign flagged vessels have less of their operation near the U.S. than U.S. flagged vessels.

Table VI.D-1  
Cost Per Ton of the Marine Tier 2 Standards for NOx.

Model Year Grouping	NPV Benefits per Ship (short tons)	NPV Operating Costs Per Ship	Engine & Vessel Costs Per Ship	Discounted Cost Per Ton
U.S. Flagged Vessels Only (proposed)				
1 to 5	1,149	\$66,000	\$115,000	\$145
6 +			\$39,000	\$87
Foreign Flagged Vessels Only (for comparison)				
1 to 5	45	\$66,000	\$57,000	\$2,590
6 +			\$39,000	\$2,235
All Vessels (for comparison)				
1 to 5	73	\$66,000	\$57,000	\$1,585
6 +			\$39,000	\$1,368

The costs and reductions presented in the above table are based on an 11,000 kW engine which, as discussed in Chapter 7 of the draft RSD, we believe represents the average sized engine visiting U.S. ports. An engine of this size would cost about \$2.5 to 3.0 million. It would be used in a vessel which would cost about \$100 to \$200 million to construct. Therefore, the \$180,000 cost estimate of engine improvements represents about 0.1 percent of the total vessel cost. All costs are in 2002 dollars.

### 3. Comparison to other programs

In an effort to evaluate the cost per ton of the NOx controls discussed above for Category 3 marine engines, we looked at the cost per ton for other recent EPA mobile source rulemakings that required reductions in NOx (or NMHC+NOx) emissions. Our final standards for Category 1 and 2 marine engines yielded a cost per ton of \$24-\$180 per ton of HC+NOx reduced (in 1997 dollars). In contrast, the 2007 standards for highway heavy-duty engines yielded a cost per ton of approximately \$1600-\$2100 per ton of NMHC+NOx (in 1999 dollars). The rulemaking proposed in this document has a low cost-per-ton value compared with other mobile source programs. Chapter 7 presents additional cost-per-ton estimates for comparison with the Draft Regulatory Support Document.



**E. What are the estimated health and environmental benefits for this proposal?**

In addition to the benefits of reducing ozone within and transported into urban ozone nonattainment areas, the NO<sub>x</sub> reductions from the new standards are expected to have beneficial impacts with respect to crop damage from ozone reductions, secondary particulate formation, acid deposition, eutrophication, visibility, and the viability and diversity of species in forests. These effects are described in more detail in Section II-B and in Chapter 2 of the Draft Regulatory Support Document.

We are not able to quantify or monetize the benefits at this time due to a lack of emissions inventories that would locate the emissions in specific ports, lack of appropriate national air quality modeling systems that can be used in marine settings, and lack of time to develop such techniques. However, to the extent that U.S.-flag Category 3 marine vessels operate in a given port area, that area would benefit from significantly reduced emissions.

**F. What would be the impacts of a low sulfur fuel requirement?**

As discussed above in section IV, we are requesting comment on low sulfur fuel requirements. This analysis looks at two approaches to meeting a cap of 15,000 ppm S beginning in 2007. The first approach is to use a low sulfur marine distillate oil which would likely be a blend of residual fuel and distillate fuel. The second approach would be to use number 2 diesel fuel (3000 ppm S) such as used in land-based applications today. These two approaches provide a range of costs and benefits that could be achieved by requiring the use of low sulfur fuel. For the purpose of this analysis, we only include the operation of ships within 175 nautical miles of the U.S. coast which is where we believe emissions will have the most significant impact on U.S. air quality.

**1. Cost and economic impacts**

Many ships are already equipped to operate on either distillate or residual fuel. Using any sort of distillate fuel for all operation near the U.S. coast could result in additional hardware costs. These costs would be for modifications to the fuel plumbing and storage associated with longer periods of operation on distillate fuel. The cost of using marine diesel oil would be about 60 percent higher than for the higher sulfur residual fuel. The cost of the number 2 diesel would be about twice the cost of operating on residual fuel. Table VI.F-1 presents the discounted lifetime costs for either using 15,000 ppm S or 3,000 ppm S fuel on all ships operating within 175 nautical miles of the U.S. coast. Chapter 5 of the Draft Regulatory Support Document develops the analysis of these cost estimates.

Table VI.F-1  
Estimated Average Per Engine Cost Increases for Alternative Approaches

Fuel Used	Increased Hardware Costs	Increased Operating Costs
15,000 ppm S residual fuel	\$50,000	\$139,000
3,000 ppm S distillate fuel	\$50,000	\$273,000

## 2. Environmental impacts

For the 1.5 percent sulfur residual fuel scenario, our estimates of SO<sub>x</sub> and PM reductions are based strictly on the reduction of sulfur in the fuel from 27,000 to 15,000 ppm. In this case by itself, no NO<sub>x</sub> reductions are anticipated. Table VI.F-2 presents the emission reductions due to using this low sulfur fuel for all operation of U.S. and foreign vessels within 175 nautical miles of the U.S. coast. However, as discussed in section IV.D, there are some issues regarding how we might enforce such a fuel requirement for all operation within 175 nautical miles of the U.S. coast.

Table VI.F-2  
Projected Category 3 Emissions Inventories for Switching to 15,000 ppm S Fuel

		1996	2010	2020	2030
PM	Baseline case (thousand short tons)	17.1	26.0	36.7	54.2
	Control case (thousand short tons)	17.1	21.3	30.1	44.5
	Reduction (thousand short tons)	--	4.7	6.6	9.7
	Percent reduction from baseline	--	18	18	18
SO <sub>x</sub>	Baseline case (thousand short tons)	156.2	192.8	271.2	399.7
	Control case (thousand short tons)	156.2	108.0	151.9	223.9
	Reduction (thousand short tons)	--	84.8	119.3	175.8
	Percent reduction from baseline	--	44	44	44

For the 3,000 ppm fuel case, our estimates of SO<sub>x</sub> reductions are based on a reduction of sulfur in the fuel from 2.7 to 0.3 percent. Our estimates of PM reductions are based on changes in several fuel components. We estimate that PM from a marine engine operating on residual fuel is made up of 45 percent sulfate, 25 percent carbon soot, 20 percent ash, and 10 percent soluble organic hydrocarbons. Reducing sulfur in the fuel would reduce direct sulfate PM by about 90 percent. In addition, if distillate fuel is used, the ash content and the density of the fuel would be reduced. This analysis results in a total per vessel PM reduction of 63 percent. Using

residual fuel can lead to NO<sub>x</sub> increases due to nitrogen in the fuel. For this analysis we use a per vessel NO<sub>x</sub> reduction of ten percent based on a reduction of nitrogen in the fuel. Table VI.F-3 presents the potential SO<sub>x</sub>, PM, and NO<sub>x</sub> reductions from using distillate fuel for all Category 3 vessel operations.

Table VI.E-3  
Projected Category 3 Emissions Inventories for Switching to 3,000 ppm S Fuel

		1996	2010	2020	2030
NO <sub>x</sub>	Baseline case (Annex VI - thousand short tons)	190.0	274.1	367.5	530.8
	Control case (thousand short tons)	190.0	246.7	330.7	477.7
	Reduction (thousand short tons)	--	27.4	36.8	51.3
	Percent reduction from Annex VI baseline	--	10	10	10
PM	Baseline case (thousand short tons)	17.1	26.0	36.7	54.2
	Control case (thousand short tons)	17.1	9.6	13.6	20.1
	Reduction (thousand short tons)	--	16.4	23.1	34.1
	Percent reduction from baseline	--	63	63	63
SO <sub>x</sub>	Baseline case (thousand short tons)	156.2	192.8	271.2	399.7
	Control case (thousand short tons)	156.2	21.2	29.8	44.0
	Reduction (thousand short tons)	--	171.6	241.4	355.7
	Percent reduction from baseline	--	89	89	89

The reductions of SO<sub>x</sub> and fine PM emissions from this alternative both within port and transported into urban areas are expected to have beneficial impacts with respect to PM-related cancer and non-cancer health effects, acid deposition, eutrophication, visibility. These effects are described in more detail in Section II-B and in Chapter 2 of the Draft Regulatory Support Document.

We are not able to quantify or monetize the benefits at this time due to a lack of emissions inventories that would locate the emissions in specific ports, lack of appropriate national air quality modeling systems that can be used in marine settings, and lack of time to develop such techniques. Nevertheless, certain ports with high traffic in U.S. flagged Category 3 marine vessels could experience significant benefits from SO<sub>x</sub> and PM reductions.

### 3. Cost per ton

We estimated the cost per ton of both 15,000 ppm sulfur residual fuel and 3,000 ppm sulfur distillate fuel. For this analysis, we consider operation of all ships within 175 nautical miles of the U.S. coast. In determining the cost per ton, we apportion the costs between reductions in PM and SO<sub>x</sub> emissions. One approach would be to apply all of the costs to PM and consider the SO<sub>x</sub> reductions to come at no additional cost; however, we recognize that there is benefit to reducing both PM and SO<sub>x</sub>. Therefore, we apply 10 percent of the cost to SO<sub>x</sub> reductions. If all the costs were applied to PM, the estimated \$/ton for PM control would be about 10 percent higher than shown below. No costs are applied to NO<sub>x</sub> control, so a cost per ton value is not presented. We request comment on this partition of costs.

Table VI.F-4  
Cost Per Ton of a Low Sulfur Fuel Requirement

Pollutant	NPV of total lifetime costs per ship	NPV of tons reduced per ship	Discounted cost per ton
15,000 ppm sulfur			
PM	\$170,000	4.3	\$38,000
SO <sub>x</sub>	\$19,000	61	\$302
3,000 ppm sulfur			
PM	\$291,000	8.7	\$33,000
SO <sub>x</sub>	\$32,000	121	\$262

## VII. Other Approaches We Considered

### A. Standards Considered

Earlier in this preamble we discuss two tiers of standards for new Category 3 marine engines. The first tier is equivalent to the MARPOL Annex VI NO<sub>x</sub> limits to which manufacturers have recently begun designing their engines. The second tier is 30 percent below this Tier 1 limit; we anticipate that this standard can be met relatively soon using in-cylinder controls. This section discusses two other approaches we considered when developing this proposal and presents our analysis of the feasibility and impacts of setting such standards. We considered alternative NO<sub>x</sub> emission standards 50 and 80 percent below Annex VI levels. Under either of these scenarios, additional lead time beyond 2007 may be necessary; however, in this discussion, we consider a 2007 implementation date for our analysis of the alternative approaches so that a direct comparison can be made to the Tier 2 standard under consideration. Our analysis of alternative approaches applies equally to U.S. and foreign vessels. Also, if we were to adopt either of these alternative standards, all the provisions for certifying engines described in Section V would apply. However, as described below, we believe it is not

appropriate to set standards for Category 3 marine engines based on these approaches at this time, due to remaining technological and operational issues. However, we may consider these approaches as the basis of new standards in the future.

1. NO<sub>x</sub> level 50 percent below Tier 1

One alternative that we are considering is an emission level one-half of the MARPOL limits. We believe reductions on this order could be achieved by introducing water into the combustion process. Water can be used in the combustion process to lower maximum combustion temperature, and therefore lower NO<sub>x</sub> formation, with an insignificant increase in fuel consumption. Water has a high heat capacity, which allows it to absorb enough of the energy in the cylinder to reduce peak combustion temperatures. Data presented below and in Chapter 8 of the Draft Regulatory Support Document suggest that a 30 to 80 percent NO<sub>x</sub> reduction can be achieved depending on ratio of water to fuel and on the method of introducing water into the combustion chamber. This data is primarily based on developmental engines; however, given enough lead time, we believe that introducing water into the combustion process may become an effective emission control strategy.

Water may be introduced into the combustion process through emulsification with the fuel, direct injection into the combustion chamber, or saturating the intake air. Water emulsification refers to mixing the fuel and water prior to injection. This strategy is limited due to instability of suspending water in fuel. To increase the effective stability, a system can be used that emulsifies the water into the fuel just before injection. Another option is to stratify the fuel and water through a single injector. The Draft Regulatory Support Document presents data on these approaches showing a 30-40 percent reduction in NO<sub>x</sub> with water fuel ratios ranging from 0.3 to 0.4.

More effective control of the water injection process can be achieved through the use of an independent nozzle for water. Using a separate injector nozzle for the water allows larger amounts of water to be added to the combustion process because the water is injected simultaneously with the fuel, and larger injection pumps and nozzles can be used for the water injection. In addition, the fuel injection timing and the amount of water injected can be better optimized. Data presented in the Draft Regulatory Support Document show NO<sub>x</sub> reductions of 40 to 70 percent with water-to-fuel ratios ranging from 0.5 to 0.9 if a separate nozzle is used for injecting water.

Other strategies for introducing water into the combustion process are being developed that will allow much higher water to fuel ratios. These strategies include combustion air humidification and steam injection. With combustion air humidification, a water nozzle is placed in the engine intake and an air heater is used to offset condensation. With steam injection, waste heat is used to vaporize water which is then injected into the combustion chamber during the compression stroke. Data on initial testing, presented in the Draft Regulatory Support Document, show NO<sub>x</sub> reductions of more than 80 percent with water to fuel ratios as high as 3.5.

Fresh water is necessary for any of these water-based NO<sub>x</sub>-reduction strategies. Introducing

salt water into the engine could result in serious deterioration due to corrosion and fouling. For this reason, a ship using water strategies would need to either produce fresh water through the use of a desalination or distillation system or store fresh water on board. Cruise ships may already have a source of fresh water that could be used to enable this technology. This water source is the “gray” water, such as drainage from showers, which could be filtered for use in the engine. However, the use of gray water would have to be tested on these engines, and systems would have to be devised to ensure proper filtering. For example, it would be necessary to ensure that no toxic wastes are introduced into the gray waste-water stream. One manufacturer stated that today’s ships operating with direct water injection carry the amount needed to operate the system between ports (two to four days). Also, when and where a ship operates can have an effect on the available water. A ship operating in cold weather uses all of the available steam heated by the exhaust just to heat the fuel. Also, a ship operating in an area with low humidity would not be able to condense water out of the air using the jacket water aftercooler.

Depending on the amount of water necessary, other vessels that use Category 3 marine engines may not be able to generate sufficient amounts of gray water for this technology. These ships would have to carry the water or be outfitted with new or larger distillation systems. Both of these options would displace cargo space. Finally, it should be noted that vessels that are currently equipped with water-based NO<sub>x</sub> reduction technologies are four-stroke engines and include fast ferries, cruise ships and cargo ships. The specific vessels travel relatively short distances between stops and need a much smaller volume of fresh water for a trip than would be required for crossing an ocean. More information is needed regarding operation on ocean-going vessels before this technology could be used as the basis for a NO<sub>x</sub> emission standard. If the ships were only to use this technology traveling from 175 nautical miles of the U.S. coast to port, less water storage capacity would be needed than if the ship used this NO<sub>x</sub> reduction strategy at all times. However, ships operating primarily within 175 nautical miles of the U.S. coast would need to be able to carry a volume of water of about one-half the volume of fuel they carry if they wish to keep the same refueling schedule. Ships making long runs, such as from California to Alaska, would have to be able to store enough water for that trip even if they make it infrequently. Lastly, if this technology were applied to two-stroke engines there may be lubricity concerns with the cylinder liner. One manufacturer is developing a strategy to use DWI with EGR to minimize water requirements on such engines.

Durability issues may be a concern with water emulsification or injection systems. For onboard water emulsifying units, cavitation is used to atomize the water and mix it into the fuel. Although this works well at emulsifying the fuel, the water can cause significant wear of the injection pump. For water injection systems, high pressure water is injected similar to in a fuel injector. However, water does not have the inherent lubrication properties found in fuel. Therefore, more research may be necessary on more durable materials.

Another concern with the use of water in the combustion process is the effect on PM emissions. The water in the cylinder reduces NO<sub>x</sub>, which is formed at high temperatures, by reducing the temperature in the cylinder during combustion. However, PM oxidation is most efficient at high temperatures. At this time, we do not have sufficient information on the effect of water emulsification and injection strategies on PM emissions to quantify this effect. We

request information on the effect of using water in the combustion process on PM emissions.

For these reasons we believe it is premature to set a standard based on water-based technologies at this time. We request comment on this approach.

## 2. NOx level 80 percent below Tier 1

The other alternative we are considering for the Tier 2 standard is an emission level 80 percent below the MARPOL limits. We believe reductions of this order could be achieved through the use of selective catalytic reduction. Selective catalytic reduction (SCR) is one of the most effective means of reducing NOx from large diesel engines. In SCR systems, a reducing agent, such as ammonia, is injected into the exhaust and both are channeled through a catalyst where NOx emissions are reduced. As discussed in the draft RSD, SCR can be used to reduce NOx emissions by more than 90 percent at exhaust temperatures above 300°C. These systems are being successfully used for stationary source applications, which operate under constant, high load conditions. These systems are also being used in Category 3 engines used on ferries and cruise ships where they operate largely at high loads and over short distances so exhaust temperature and urea storage are not primary issues.

Several issues exist before application of this technology to all Category 3 engines can be deemed feasible. Issues include temperature at low load for SCR effectiveness, use of low sulfur fuel for system durability, space required for the SCR unit and urea storage, availability of regular down time for repair, availability of urea at ports, and application to slow-speed engines.

SCR systems available today are effective only over a narrow range of exhaust temperatures (above 300°C). To date, these systems have primarily been applied to four-stroke medium speed engines which have exhaust temperatures above 300°C at least at high load. Two-stroke slow speed engines have lower exhaust temperatures and are discussed later. The effectiveness of the SCR system is decreased at reduced temperatures exhibited during engine operation at partial loads. Most of the engine operation in and near commercial ports and waterways close to shore is likely to be at these partial loads. In fact, reduced speed zones can be as large as 100 miles for some ports. Because of the cubic relationship between ship speed and engine power required, engines may operate at less than 25 percent power in a reduced speed zone. During this low load operation, no NOx reduction would be expected, therefore SCR would be less effective than the proposed Tier 2 standards during low load operation near ports. Some additional heat to the SCR unit can be gained by placing the reactor upstream of the turbocharger; however, this temperature increase would not be large at low loads and the volume of the reactor would diminish turbocharger response when the engine changes load. The engine could be calibrated to have higher exhaust temperatures; however this could affect durability (depending on the fuel used) if this calibration also increased temperatures at high loads. For an engine operating on residual fuel, vanadium in the fuel can react with the valves at higher temperatures and damage the valves.

SCR systems traditionally have required a significant amount of space on a vessel; in some cases the SCR was as large as the engine itself. However, at least one manufacturer is

developing a compact system which uses an oxidation catalyst upstream of the reactor to convert some NO to NO<sub>2</sub> thus reducing the reactor size necessary. The reactor size is reduced because the NO<sub>2</sub> can be reduced without slowing the reduction of NO. Therefore, the catalytic reaction is faster because NO<sub>x</sub> is being reduced through two mechanisms. This compact SCR unit is designed to fit into the space already used by the silencer in the exhaust system. If designed correctly, this could also be used to allow the SCR unit to operate effectively at somewhat lower exhaust temperatures. The oxidation catalyst and engine calibration would need to be optimized to convert NO to NO<sub>2</sub> without significant conversion of S to direct sulfate PM. NO<sub>x</sub> reductions of 85 to 95 percent have been demonstrated with an extraordinary sound attenuation of 25 to 35 dB(A).<sup>56</sup>

Information from one manufacturer who has 40 installations of SCR reveals that the engines using the technology are either using low sulfur residual fuel (0.5%-1% S) or distillate fuel. Low sulfur residual fuel is available in areas which provide incentives for using such fuel, including the Baltic Sea, however such fuel is not yet available at ports throughout the United States. However, distillate fuel is available. Low sulfur fuel is necessary to assure the durability of the SCR system because sulfur can become trapped in the active catalyst sites and reduce the effectiveness of the catalyst. This is known as sulfur poisoning which can require additional maintenance of the system. The operation characteristics of ocean going vessels may interfere with correct maintenance of the SCR system. Ferries which have incorporated this technology to date do not run continuously and therefore any maintenance necessary can be performed during regular down times. The availability of time for repair can be an issue for ocean going vessels for they do not have regular down times.

Sulfur in fuel is also a concern with an oxidation catalyst because, under the right conditions, sulfur can also be oxidized to form direct sulfate PM. At higher temperatures, up to 20 percent of the sulfur could be converted to direct sulfate PM in an oxidation catalyst compared to about a 2 percent conversion rate for a typical diesel engine without aftertreatment. Depending on the precious metals used in the SCR unit, it could be possible to convert some sulfur to direct sulfate PM in the reactor as well. Manufacturers would have to design their exhaust system (and engine calibration) such that temperatures would be high enough to have good conversion of NO, but low enough to minimize conversion of S to direct sulfate PM. Direct sulfate PM emissions could be reduced by using lower sulfur fuel such as distillate.

A vessel using a SCR system would also require an additional tank to store ammonia (or urea to form ammonia). This storage tank would be sized based on the vessel use, but could be large for a vessel that travels long distances in U.S. waters between refueling such as between California and Alaska. The urea consumption results in increased operating costs. Also, if lower sulfur diesel fuel were required to ensure the durability of the SCR system or to minimize direct sulfate PM emissions, this lower sulfur fuel would increase operating costs. For SCR to be effective, an infrastructure would be necessary to ensure that ships could refuel at ports they visit.

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<sup>56</sup> Paro, D., "Effective, Evolving, and Envisaged Emission Control Technologies for Marine Propulsion Engines," presentation from Wartsila to EPA on September 6, 2001.



We believe that it would take some time to set up a system for getting fuel to ships that fill up using barges, especially if the standard were only to apply to U.S. flagged ships due to the low production volume. In addition, a ship that operates outside the U.S. for several months (or years) would have to ensure that it has urea available for any visits to U.S. ports.

Because SCR units are so easily adjustable, ship operators may choose to turn off the SCR unit when not operating near the U.S. coast. If they were to use this approach, they would need to construct a bypass in the exhaust to prevent deterioration of the SCR unit when not in use. To ensure that the SCR system is operating properly within 175 nautical miles of the U.S. coast, we would need to consider continuous monitoring of NO<sub>x</sub> emissions for engines using SCR. Discussions of equipment and procedures for continuous monitoring are currently under discussion by IMO in the context of Annex VI.

If the combustion is not carefully controlled, some of the ammonia can pass through the combustion process and be emitted as a pollutant. This is less of an issue for Category 3 marine engines, which generally operate under steady-state conditions, than for other mobile-source applications. In addition, in ships where banks of engines are used to drive power generators, such as cruise ships, the engines generally operate under steady-state conditions near full load. If ammonia slip still occurred, an oxidation could be used downstream of the reactor to burn off the excess ammonia.

Slow-speed marine engines generally have even lower exhaust temperatures than medium speed engines due to their two-stroke design. However, we are aware of four slow-speed Category 3 marine engines that have been successfully equipped with SCR units. Because of the low exhaust temperatures, the SCR unit is placed upstream of the turbocharger to expose the catalyst to the maximum exhaust heat. Also, the catalyst design required to operate at low temperatures is very sensitive to sulfur. Especially at the lower loads, the catalyst is easily poisoned by ammonium sulfate that forms due to the sulfur in the fuel. To minimize this poisoning on these four in-service engines, highway diesel fuel (0.05% S) is required. In addition, these ships only operate with the exhaust routed through the SCR unit when they enter port in the U.S. which is about 12 hours of operation every 2 months. Therefore, the sulfur loading on the catalyst is much lower than it would be for a vessel that continuously used the SCR system. To prevent damage to the catalyst due to water condensation, this system needs to be warmed up and cooled down gradually using external heating. Another issue associated with the larger slow-speed engines and lower exhaust temperatures is that a much larger SCR system would be necessary than for a vessel using a smaller medium-speed engine. Size is an issue because of the limited space on most ships.

We believe that more time is necessary to resolve the issues discussed above for the application of SCR to Category 3 marine engines. Therefore, we are not proposing to set a standard at this time that would require the use of a SCR system. However, given enough lead time, we believe that manufacturers will be able to refine their designs for efficiency, compactness, and cost. Therefore, we believe that SCR may be available for widespread application with Category 3 marine engines in the future, and we intend to consider this technology if or when we propose additional standards in the future. We are also including this

technology in our Blue Cruise program because of the potential large NO<sub>x</sub> reductions and because this technology may be an attractive NO<sub>x</sub> control strategy for cruise ship which use banks of engines generally operating at high load. Because cruise ships make frequent stops on regular routes, they should be able to coordinate a workable urea supply strategy. We request comment on using SCR technology on ocean-going vessels and on setting voluntary standards based on SCR technology.

A second approach for meeting an 80 percent reduction in NO<sub>x</sub> emissions would be to use fuel cells to power the vessel in place of an internal combustion engine. A fuel cell is like a battery except where batteries store electricity, a fuel cell generates electricity. The electro-chemical reaction taking place between two gases, hydrogen and oxygen generate the electricity from the fuel cell. The key to the energy generated in a fuel cell is that the hydrogen-oxygen reaction can be intercepted to capture small amounts of electricity. The byproduct of this reaction is the formation of water. Current challenges include the storage or formation of hydrogen for use in the fuel cell and cost of the catalyst used within the fuel cell.

Over the past 5 years several efforts to apply fuel cells to marine applications have been conducted. These include grants from the Office of Naval Research and the U.S. Navy. The Office of Naval Research initiated a three-phase advanced development program to evaluate fuel cell technology for ship service power requirements for surface combatants in 1997. In early 2000, the U.S. Navy sponsored an effort to continue the development of the molten carbonate fuel cell for marine use. The Society of Naval Architects and Marine Engineers released the technical report "An Evaluation of Fuel Cells for Commercial Ship Applications." The report examines fuel cells for application in commercial ships of all types for electricity generation for ship services and for propulsion.

Fuel cell research is currently supported by several sources. including the U.S. Maritime Administration (MARAD) and the state of California's Fuel Cell Partnership. MARAD's Division of Advanced Technology has also included the topic of fuel cells as a low air emission technology that should be demonstrated. California's Fuel Cell Partnership seeks to achieve four main goals which include 1) Demonstrate vehicle technology by operating and testing the vehicles under real-world conditions in California; 2) Demonstrate the viability of alternative fuel infrastructure technology, including hydrogen and methanol stations; 3) Explore the path to commercialization, from identifying potential problems to developing solutions; and 4) Increase public awareness and enhance opinion about fuel cell electric vehicles, preparing the market for commercialization.

At this time, we consider fuel cell technology still be in the early stages of development. We recognize that a mature fuel cell system could have significant environmental benefits and we will consider this technology in the future. We request comment on the feasibility of using fuel cells for power on marine vessels.

## **B. Potential Impacts of the Regulatory Alternatives**

### **1. Costs**

The following analysis presents estimated cost increases for Category 3 marine engines and vessels that would be associated with the alternative standards (see Table VII.B-1). This cost analysis follows the same methodology outlined above (VI.B) and described in more detail in the Draft Regulatory Support Document. For the 50 percent below Tier 1 case, hardware costs include water injectors, plumbing, and water storage. Operating costs include water and a small fuel oil consumption penalty. For the 80 percent below Tier 1 case, hardware costs include the cost of the SCR unit and operating costs include the cost of the urea. In the analysis of these two scenarios, we only include the operation of ships where we believe emissions will have the most significant impact on U.S. air quality. The entire increased production cost is therefore included, but the increased operating costs are only considered for operation within 175 nautical miles of the U.S. coast. These costs are based on year 1 (no learning curve adjustment) and are discounted at a rate of seven percent to present the net present value.

Table VII.B-1 presents our cost estimates for applying the standards to U.S. flagged vessels only and for applying the standards to all vessels operating within 175 nautical miles of the U.S. coast. When applying the costs to all vessels, the production costs decrease because the development costs are spread among more engines; operating costs decrease because the average vessel spends less time operating near the U.S. coast than the average U.S. flagged vessel. For water injection, the operating costs include the effective cost of the water. For SCR, the operating costs include urea consumption as well as ship operation on 0.05 percent sulfur fuel. These costs are for an average sized Category 3 marine engine which would cost about 2.5 to 3.0 million dollars. For the 50 percent below Tier 1 case, the increased production costs range from 3 to 6 percent of the cost of the engine. For the 80 percent below Tier 1 case, the increased production costs range from 20 to 25 percent of the cost of the engine.

Table VII.B-1  
Estimated Average Cost Increase Per Ship for Alternative NOx Standards

Alternative Standard	Increased Production Costs per Ship (thousand \$)	Increased Operating Costs per Ship (thousand \$)
US Flagged Vessels Only		
50% below Tier 1	\$207	\$527
80% below Tier 1	\$1,014	\$9,542
Foreign Flagged Vessels Only		
50% below Tier 1	\$137	\$84
80% below Tier 1	\$972	\$410
All Vessels		
50% below Tier 1	\$137	\$95
80% below Tier 1	\$972	\$629

## 2. Reductions

We use the same methodology to model emissions inventories for the alternative approaches as we used for the proposed Tier 2 standards. This is outlined earlier in the preamble (VI.B) and described in more detail in the Draft Regulatory Support Document. Table VII.B-2 presents our estimates of Category 3 vessel emission reductions possible through the alternative standards applied only to U.S. flagged vessels. Table VII.B-3 presents our estimates of Category 3 vessel emission reductions possible through the alternative standards applied to all Category 3 vessels. As for the cost analysis, we only include operation within 175 nautical miles of the U.S. coast, so only the emission reductions in that area are presented below.

Table VII.B-2  
Projected Category 3 NOx Reductions  
for Alternative Approaches Applied to U.S. Flagged Vessels

		1996	2010	2020	2030
Tier 1	Control case (thousand short tons)	190.0	274.1	367.5	530.8
50% below Tier 1	Control case (thousand short tons)	190.0	265.6	326.8	439.1
	Percent reduction from Tier 1	--	3.1	11.1	17.3
80% below	Control case (thousand short tons)	190.0	260.4	301.9	382.9
	Percent reduction from Tier 1	--	5.0	17.8	27.9

Table VII.B-3  
Projected Category 3 NOx Reductions for Alternative Approaches  
Applied to All Vessels

		1996	2010	2020	2030
Tier 1	Control case (thousand short tons)	190.0	274.1	367.5	530.8
50% below Tier 1	Control case (thousand short tons)	190.0	260.7	276.9	311.2
	Percent reduction from Tier 1	--	4.9	24.7	41.4
80% below Tier 1	Control case (thousand short tons)	190.0	252.5	221.4	176.7
	Percent reduction from Tier 1	--	7.9	39.8	66.7

### 3. Cost per ton

To determine the cost per ton of NOx reduction of the Tier 2 emission standards described in this notice, we considered only benefits beyond those achieved by the Tier 1 standards (equivalent to the Annex VI standards). Although the Annex VI standards are not yet effective, manufacturers around the world are generally producing compliant engines and we expect this to continue. Thus, we are using the proposed Tier 1 standards as the baseline, and showing the benefits of the Tier 2 standards under consideration relative to this baseline. Table VII.B-4 presents the cost per ton of the alternative standards using the same methodology discussed for the potential Tier 2 standards above. For this analysis, we considered all costs incurred and emission reductions achieved within 175 nautical miles of the U.S. coast. The cost estimates presented here do not include future reductions in cost due to the learning curve. Both costs and benefits are discounted at a rate of seven percent.

In addition, this analysis presents estimates both for applying the alternative standards just to U.S. flagged and for applying the alternative NOx standards to all vessels operating in U.S. waters. By including foreign flagged vessels under these alternative approaches, the cost per engine decreases because the development costs can be distributed across more engines. However, the cost per ton actually increases because U.S. flagged vessels spend about 16 times more of their operating time within 175 nautical miles of the U.S. coast than foreign flagged vessels. Therefore, the tons of NOx reduced per year in U.S. waters for an average foreign flagged vessel (which make up about 97 percent of the vessels) are lower. Operating costs included in this analysis would still be proportional to the amount of time the ship operates within 175 nautical miles of the U.S. coast.

Table VII.B-4  
Cost Per Ton of the Alternative NOx Control Approaches

Approach	NPV of total lifetime costs (thousand \$) per ship	NPV of NOx tons reduced per ship	Discounted cost per ton
US Flagged Vessels Only			
50% below Tier 1	\$734	1,915	\$370
80% below Tier 1	\$10,557	3,064	\$3,405
Foreign Flagged Vessels Only			
50% below Tier 1	\$220	75	\$2,737
80% below Tier 1	\$1,381	119	\$10,607
All Vessels			
50% below Tier 1	\$232	122	\$1,768
80% below Tier 1	\$1,601	195	\$7,618

### C. Summary

We considered two alternative approaches to a Tier 2 NOx standard, namely a 50 or 80 percent reduction below Tier 1.

For a 50-percent reduction, we considered water injection with 0.5 water to fuel ratio. At the present time, the cost per ton for the water injection system ranges from \$370 to \$1,768 depending on if it applies to U.S. flagged vessels only or all vessels operating within 175 nautical miles of the U.S. coast. This analysis does not consider the lost space on a vessel due to water storage, nor does it consider the alternative of adding water distillation boilers which would add cost to the vessel, require space, and require additional fuel consumption. Water storage would either displace fuel storage and reduce the range of the vessel or reduce cargo space which would affect the money generated per cruise. In addition, more information is necessary on the effects of this technology on PM emissions. Because the water reduces the temperature in the combustion chamber, we are concerned that this could result in an increase in PM. Although this technology may be more attractive in the future, we are not focused on considering standards at this level at this time due to the water storage issues as well as the development time of advances in this technology to address lubricity concerns in the cylinder liners of two-stroke engines.

For the 80 percent NOx reduction case, we considered the use of selective catalytic reduction with a urea consumption rate of about 8 percent of the fuel consumption rate. Our estimated cost per ton for this approach ranges from \$3,405 to \$7,618 depending on if it applies to U.S. flagged vessels only or all vessels operating within 175 nautical miles of the U.S. coast. This is considerably higher than the cost per ton figures for the recent mobile source programs presented in Chapter 7 of the Draft RSD. The cost per ton estimate for the use of SCR includes

the cost of using lower sulfur fuel which we believe would be necessary for the durability of the system and to prevent increases in direct sulfate PM. In the future, however, technological advances increase the effectiveness of these units at lower temperatures and may reduce the cost of this system.

For SCR to be effective, an infrastructure would be necessary to ensure that ships could refuel at ports they visit. We believe that it would take some time to set up a system for getting fuel to ships that fill up using barges, especially if the standard were only to apply to U.S. flagged ships due to the low production volume. SCR would require space for urea storage, but it would likely be much less than that for water storage in the above approach because the volume of urea needed is only 5-10 percent of the volume of water needed for the water injection case considered above. In addition, at least one manufacturer is developing a compact SCR unit that will minimize the space needed for this system. We also believe that there are technical issues that need to be resolved such as effectiveness at low loads and the effect of the catalyst in the exhaust on direct sulfate PM emissions. As with water injection, we believe SCR may be appropriate for certain applications, but also believe that the remaining technology development and system cost prevent us from expecting manufacturers to apply SCR to all Category 3 marine engines at this time. We are therefore proposing to designate 80-percent reductions as a target for recognition as voluntary low-emission engines, rather than considering mandatory standards based on this technology.

#### **D. Speed-based vs. Displacement-based Emission Standards**

Annex VI specifies the NO<sub>x</sub> emission standard as a function of engine speed. The shape of this curve was established with a mathematical relationship based on available emission data showing uncontrolled NO<sub>x</sub> emission rates as a function of maximum engine speed. The numerical level of the standard was set based on a fixed percentage reduction relative to uncontrolled emission levels. The shape of the curve generally allows for higher emissions from larger engines, which tend to operate at slower speeds. On the other hand, a given percentage reduction for all engine sizes yields greater brake-specific emission reductions from larger engines, with greater percentage reductions flattening the curve.

This speed-based approach to setting standards has several advantages. It reflects the inherent tendency of larger (and slower-speed) engines to have higher NO<sub>x</sub>-formation rates. It correspondingly reflects the challenges facing the design engineer to apply technology to reduce emissions. While maximum engine speeds can vary somewhat for a given engine, this parameter provides an effective correlation to an engine's emissions behavior. This is borne out by the emission data showing the trend of emissions as a function of engine speed on which the Annex VI NO<sub>x</sub> curve is based. Also, defining the emission standard as a formula instead of setting different standards for discrete ranges prevents any complications related to step changes in the standard at any particular engine speed.

While we believe it is appropriate for the emission standards to be consistent with the Annex VI formula, this approach raises two issues that may become significant in the future. First, maximum engine speed is a design variable that can be set by the manufacturer based on an

engine's particular application or a shipowner's preference. Under the speed-based formula, a manufacturer selling two otherwise identical engines may install them in different vessels that call for differing engine-speed ratings, which would allow the manufacturer to produce the engines to operate at different emission levels. For a given engine, it's not clear that emission standards should allow a higher emission level for engine installations that call for a lower speed rating. Table VII.D-1 shows the effect of speed rating on the applicable emission standard for selected engine models that are currently available. For some engines, varying engine speed causes a difference in the NO<sub>x</sub> standard of over 0.5 g/kW-hr.

Table VII.D-1  
Effect of Engine Speed on Emission Standards for Selected Engines

Engine	Speed 1 (rpm)	Standard 1 (g/kW-hr)	Speed 2 (rpm)	Standard 2 (g/kW-hr)	difference (g/kW-hr)	Percent increase
1	111	17.0*	148	16.6	0.4	2.6%
2	132	16.9	176	16.0	0.9	5.9%
3	212	15.4	250	14.9	0.5	3.4%
4	330	14.1	360	13.9	0.2	1.8%
5	720	12.1	1000	11.3	0.8	6.8%

\*The NO<sub>x</sub> formula would allow for emissions up to 17.5 g/kW-hr for an engine speed of 111 rpm, but Annex VI caps the NO<sub>x</sub> standard at 17 g/kW-hr for engines with rated speed below 130 rpm.

The second concern with a speed-based emission standard is that future emission-control technologies may allow for more effective control of NO<sub>x</sub> emissions at slow engine speeds. This would allow for a “flatter” NO<sub>x</sub> curve, or even a single NO<sub>x</sub> standard that would apply for all Category 3 engines, regardless of speed rating. It would not be appropriate to allow for higher emissions on low-speed engines if an emission-control technology enables a flatter relationship between NO<sub>x</sub> emissions and engine speed. This will become especially important if or when there is a need to adopt PM emission standards, since PM emissions are unlikely to follow the same relationship to engine speed as NO<sub>x</sub> emissions.

The alternative approach to defining emission standards would be to follow the approach in EPA's December 1999 rulemaking for Category 1 and Category 2 marine engines. Defining emission standards based on an engine's specific displacement (in liters per cylinder) would provide a clear and discrete emission standard for each engine. Table VII.D-2 shows a variety of typical engine sizes and engine-speed values correlated with the Tier 2 NO<sub>x</sub> standards discussed in section IV.A.3 that would apply to each engine. A straightforward regression of specific displacement values and the Tier 2 NO<sub>x</sub> levels shows a good correlation using the following simple formula:

$$\text{NO}_x = 0.0047 \times (\text{L/cyl}) + 9.9$$



The calculated value using this formula is within 0.1 g/kW-hr across the range of engines shown in Table IV.D-2. Most two-stroke engines operate at less than 130 rpm and are therefore subject to the capped standard that doesn't vary with engine speed. The table therefore includes no two-stroke engines. Many of these slow-speed engines, however, have specific displacements between 100 and 300 L/cyl. To implement a displacement-based standard that parallels the Annex VI approach, we would need to apply a cap of 13.3 g/kW-hr on the Tier 2 emission standards under consideration for two-stroke (or slow-speed) engines over 700 L/cyl, while using the above equation to define the emission standard for smaller engines. On the other hand, it may be more appropriate to adopt standards reflecting the relative power output of the slow-speed engines. Slow-speed engines generally produce about half as much power as medium-speed engines for a given displacement, so we could set comparable standards by using the displacement-based formula above, but dividing the displacement term by two for slow-speed engines. This would take into account the lower specific power from slow-speed engines, resulting in comparable standards for competing engines with similar total power output.

Table VII.D-2  
Values Related to Displacement-based Standards\*

Engine Model	Engine speed (rpm)	Per-Cylinder displacement (L)	Tier 2 Standard	Tier 2 standard using displacement formula
Niigata 34HX	600	41	10.2	10.1
MAN B&W L48/60	514	109	10.4	10.4
MAN B&W PC4.2B	430	168	10.8	10.7
Wärtsilä 64	400	225	10.9	11.0
Wärtsilä 64 (longer stroke)	330	290	11.3	11.3
—	130	700**	13.3	13.2**

\*Source: Diesel and Gas Turbine Worldwide Catalog, 2001.

\*\*extrapolation.

The near-term adoption of emission standards equivalent to the Annex VI standards would not allow for restructuring emission standards based on displacement. It is also not clear that the advantages of displacement-based standards would warrant departing from the approach established internationally in the near term. We request comment on the appropriateness of adopting a displacement-based NO<sub>x</sub> standard. We also request comment regarding the above formula and table of values and their use in establishing Tier 2 NO<sub>x</sub> standards. We specifically request comment on whether the projected Tier 2 emission-control technologies would be expected to follow the trends implicit in the Annex VI formula. Finally, we request comment on the appropriateness of basing emission standards for two-stroke engines on engine speed (with standards set at the maximum value) or whether they should be expected to achieve the same degree of emission control as counterpart four-stroke engines with comparable power ratings.

## **VIII. The Blue Cruise Program**

### **A. What Is the Blue Cruise Program?**

As noted in previous sections, fleet turnover for marine vessels that use Category 3 marine diesel engines is very slow. The average life of these vessels is as high as 29 years, and many are scrapped only when their hulls can no longer be repaired. One consequence of the long lives of these vessels is that the full impact of an engine emission control program may not occur until well into the future.

To address this issue, and to create a mechanism to encourage purchasers of new ships to use advanced technology emission controls, we are proposing to develop a Blue Cruise program. This would be a voluntary program to encourage ship owners and operators to reduce their air and waste emissions and in so doing reduce the adverse impacts of their vessels on the environment. Basically, participant ship owners would be awarded a number of stars based on the types of air and waste emission control programs they adopt. These technologies and/or systems would be different depending on whether it is a new or existing vessel. The stars can be used by the participants on advertising materials, and even on the ship itself, to educate consumers and encourage them to choose their vessel for their transportation needs. Although the program is perhaps best suited to cruise ships, parts of the program could be extended to other types of ships as well. These stars would be issued to an individual ship, not an entire fleet.

The Blue Cruise program would be a cross-media program. This means that it would include the air and waste emissions of a vessel, including both solid and liquid waste. By choosing one option from each of the three categories, air, liquid waste, and solid waste, participants would reduce their overall impact on the marine environment.

The program described below is focused on cruise ships. This is because their emissions on a per vessel basis can be very high, both in terms of engines used to generate power for passenger comfort and entertainment and in terms of waste streams, including gray and black water and solid waste. According to Bluewater Network, a typical cruise ship generates as much as 210,000 gallons of sewage and 1,000,000 gallons of graywater, 130 gallons of hazardous wastes, and 8 tons of garbage during a one-week voyage.<sup>57</sup> Disposal of these wastes is controversial, and a report issued by the General Accounting Office in 2000 indicates that in the six-year period between 1993 and 1998, “cruise ships were responsible for 87 confirmed illegal discharge cases

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<sup>57</sup>See Bluewater Network’s Petition to EPA to Address Cruise Ship Pollution, March 17, 2000. A copy of this document can be found in Docket A-2001-11, Document No. II-B-02. The August 2, 2000 Addendum to this Petition, regarding air emissions from cruise ships, can be found at A-2001-11, Document No. II-B-03.

in U.S. waters.”<sup>58</sup> In August 2000, the Bluewater Network sent an addendum to that petition, requesting EPA to also examine air pollution from cruise ships.

At the same time, cruise ship owners have taken steps to manage their waste streams more carefully. In June, 2001, the members of the International Council of Cruise Lines (ICCL), whose members include the major cruise lines that visit U.S. ports, adopted mandatory environmental standards that are to be integrated into each members’ internationally mandated Safety Management Systems.<sup>59</sup> These standards address the waste streams noted in the Bluewater Network petition. In addition, ICCL has entered into a Memorandum of Understanding with State of Florida regarding waste management.

The Blue Cruise Program would expand on these recent pollution reduction activities by encouraging and rewarding cruise ship owners who take additional steps to reduce emissions and/or ensure that pollution reduction practices and measures are adhered to. While the focus in this discussion is on cruise ships, we request comment on whether this program should also apply to cargo and other commercial vessels and, if so, if the point system should be different for those vessels.

## **B. How Would the Program Work?**

The Blue Cruise Program would have two components. The first component consists of making a commitment to reduce emissions through the application of technologies and/or systems that would reduce air pollution, water discharges, and waste streams. The second step involves ensuring that the equipment and/or systems that a ship owner agreed to apply are operating and being maintained correctly.

It should be noted that, due to the complexity of the program associated with its cross-media nature, the discussion of the Blue Cruise program in this section is not meant to be a comprehensive. Instead, it is a brief description of the overall concept that is meant to stimulate discussion of the value of such a program and the provisions it should include. We will continue to develop this program, soliciting comments from interested parties, as we prepare our final rule.

### **1. A Commitment To Reduce Emissions**

To participate in the Blue Cruise program, a ship owner would need to take steps to reduce air emissions, water discharges, and waste streams from the vessel. For air pollution, this could

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<sup>58</sup>Marine Pollution: Progress Made to Reduce Marine Pollution by Cruise Ships, but Important Issues Remain. February 2000, GAO/RCED-00-48. A copy of this report can be found in Docket A-2001-11, Document No. II-A-22.

<sup>59</sup>ICCL Industry Standard E-01-01 (Revision 1), Cruise Industry Waste Management Practices and Procedures (see <http://www.iccl.org/policies/environmentalstandards.pdf>) A copy of this document can be found in Docket A-2001-11, Document No. II-A-21.

involve installing new emission control devices on the ship's engine. For liquid waste pollution, this could involve applying new water treatment technology. For solid waste, this could involve developing systems to reduce, reuse, and recycle solid waste, as evidenced by joining EPA's WasteWise Program.<sup>60</sup> The exact choice of technologies and systems, of course, would depend on the technologies that are already in use on the vessel and the level of investment the ship owner desires to make. The key requirement is that the ship owner take steps to reduce three kinds of emissions: air, water, and solid waste.

The first step toward obtaining Blue Cruise status would be to sign up to the program. Similarly to the WasteWise program, a participant would assess the ship's air and waste streams and current state of pollution reduction technology; identify and submit goals, including obtaining and using new technologies and/or procedures; and measure and report progress. Successful participants would be awarded a number of stars, with five stars being the maximum number of stars awarded, which could be used to inform consumers and the world at large that they are taking steps to reduce emission beyond what is legally required. Once a participant signs up for the program, the actions agreed to become mandatory. In other words, while opting into the program is voluntary, compliance with the provisions once they are opted into is not.

We are proposing to develop a matrix of options that can be used by ship owners to make their emission control decisions. An example of a matrix is shown in Table VIII.B-1. In general, each option would be assigned a number of points, and stars would be given out depending on the number of points across all categories. A ship owner will be required to take action in each category, however.

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<sup>60</sup>WasteWise is a free, voluntary partnership program that helps organizations reduce their solid waste streams. The program provides technical assistance, networking, and recognition for successful waste reduction. Members are required to assess their waste streams, identify and submit waste reduction goals, and measure and report progress annually. More information about the WasteWise program can be found at the Office of Solid Waste website <http://www.epa.gov/wastewise>

Table VIII.B-1  
Draft Blue Cruise Program Options Matrix

Category	Action	Pts
Air	Use low sulfur fuel while within 200 miles of U.S. coast (out 320 nautical miles)	
	Use shore-side power for hotelling	
	Retrofit emission control devices when existing ships go in for refurbishing – Tier 1 technologies	
	Retrofit emission control devices when existing ships go in for refurbishing – additional engine-based controls	
	Retrofit emission control devices when existing ships go in for refurbishing – Tier 1 and 2 technologies	
	Use engines that meet Voluntary Low Emission Standards for new builds	
	Other	
Water	Implement education programs for passengers on waste minimization	
	Use biodegradable and bio-enzymatic cleaning supplies, non-phosphate soaps, and materials (e.g., toiletries supplied to passengers, salon chemicals, photo processing chemicals, etc.)	
	Ensure that all sinks, showers, toilets, hoses, etc. are low flow	
	Ensure that only shower, galley, and stateroom sink wastes enter the gray water system	
	Install gray water treatment systems that allow gray water to be used aboard the vessel for nonhuman consumption purposes	
	At a minimum meet the Alaska Standards for Gray and Black Water Discharges and incorporate this program into the ship Environmental Management System plan	
	Other	
Solid Waste	Recycle materials shore side (possibly set up a closed loop, where vessel waste is recycled and sold to the vessel as new products)	
	Sign on to MOU with the States new approach to tracking RCRA waste and implement	
	Participate in WasteWise	
	Other	

We request comment on all aspects of this program, and especially on this approach to awarding stars under the program and the contents of the options table and point system. We also request comment on whether points should be weighted and, if so, how. For example, more weight could be assigned to air emissions for cruise ships since they are currently taking steps to reduce their waste emissions pursuant to the Cruise Industry Waste Management Practices and Procedures. Finally, we request comment on whether EPA should manage this program or whether it can be run by an independent organization.

## **2. Verification**

For the Blue Cruise program to be meaningful, it will be necessary to ensure that not only ship owners install emission control technologies and equipment, but also that they are operated and maintained correctly. There are at least two ways to do this: self certification and third party verification.

With a self-certification system, a ship owner would certify to EPA annually that the emission control technologies and systems described in the application are functional and are being operated and maintained correctly. If a ship owner is unable to make this certification, then that ship's stars would be taken away and the ship would be disqualified from the program until ship can be brought back into compliance.

With a third party verification program, an outside entity would ensure that the emission control technologies and systems are functional and are being operated and maintained correctly. This approach may be necessary, at least at the beginning of the program, until the industry gains experience with the program. A model for third party verification could be the Coast Guard procedures put in place to conduct waste management inspections on board cruise vessels.

We request comment on these verification approaches, particularly on how a third party verification program can work.

## **IX. Public Participation**

We request comment on all aspects of this proposal. This section describes how you can participate in this process.

### **A. How do I submit comments?**

We are opening a formal comment period by publishing this document. We will accept comments during the period indicated under "DATES" above. If you have an interest in the proposed emission control program described in this document, we encourage you to comment on any aspect of this rulemaking. We also request comment on specific topics identified throughout this proposal.

Your comments will be most useful if you include appropriate and detailed supporting

rationale, data, and analysis. If you disagree with parts of the proposed program, we encourage you to suggest and analyze alternate approaches that meet the air quality goals described in this proposal. You should send all comments, except those containing proprietary information, to our Air Docket (see "Addresses") before the end of the comment period.

If you submit proprietary information for our consideration, you should clearly separate it from other comments by labeling it "Confidential Business Information." You should also send it directly to the contact person listed under "FOR FURTHER INFORMATION CONTACT" instead of to the public docket. This will help ensure that no one inadvertently places proprietary information in the docket. If you want us to use your confidential information as part of the basis for the final rule, you should send a nonconfidential version of the document summarizing the key data or information. We will disclose information covered by a claim of confidentiality only through the application of procedures described in 40 CFR part 2. If you don't identify information as confidential when we receive it, we may make it available to the public without notifying you.

## **B. Will there be a public hearing?**

We will hold a public hearing on June 13, 2002 at the Hyatt Regency Long Beach, 200 South Pine Avenue, Long Beach, California, phone (562) 491-1234 . The hearing will start at 9:30 am and continue until everyone has had a chance to speak.

If you would like to present testimony at the public hearing, we ask that you notify the contact person listed above at least ten days before the hearing. You should estimate the time you will need for your presentation and identify any needed audio/visual equipment. We suggest that you bring copies of your statement or other material for the EPA panel and the audience. It would also be helpful if you send us a copy of your statement or other materials before the hearing.

We will make a tentative schedule for the order of testimony based on the notifications we receive. This schedule will be available on the morning of the hearing. In addition, we will reserve a block of time for anyone else in the audience who wants to give testimony.

We will conduct the hearing informally, and technical rules of evidence won't apply. We will arrange for a written transcript of the hearing and keep the official record of the hearing open for 30 days to allow you to submit supplementary information. You may make arrangements for copies of the transcript directly with the court reporter.

## **X. Administrative requirements**

### **A. Administrative Designation and Regulatory Analysis (Executive Order 12866)**

Under Executive Order 12866 (58 FR 51735, October 4, 1993), the Agency must determine whether the regulatory action is "significant" and therefore subject to review by the Office of Management and Budget (OMB) and the requirements of this Executive Order. The Executive

Order defines a "significant regulatory action" as one that is likely to result in a rule that may:

- Have an annual effect on the economy of \$100 million or more or adversely affect in a material way the economy, a sector of the economy, productivity, competition, jobs, the environment, public health or safety, or State, local, or tribal governments or communities;
- Create a serious inconsistency or otherwise interfere with an action taken or planned by another agency;
- Materially alter the budgetary impact of entitlements, grants, user fees, or loan programs, or the rights and obligations of recipients thereof; or
- Raise novel legal or policy issues arising out of legal mandates, the President's priorities, or the principles set forth in the Executive Order.

EPA has determined that this rule is a "significant regulatory action" under the terms of Executive Order 12866 because it raises novel legal or policy issues due to the international nature of the use of Category 3 marine diesel engines and is therefore subject to OMB review. The Agency believes that this proposed regulation would result in none of the economic effects set forth in Section 1 of the Order. A Draft Regulatory Support Document has been prepared and is available in the docket for this rulemaking and at the internet address listed under "ADDRESSES" above. Written comments from OMB and responses from EPA to OMB are in the public docket for this rulemaking.

**B. Regulatory Flexibility Act (RFA), as Amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (SBREFA), 5 USC 601 et. seq.**

The RFA generally requires an agency to prepare a regulatory flexibility analysis of any rule subject to notice and comment rulemaking requirements under the Administrative Procedure Act or any other statute unless the agency certifies that the rule will not have a significant economic impact on a substantial number of small entities. Small entities include small businesses, small organizations, and small governmental jurisdictions.

For purposes of assessing the impacts of today's rule on small entities, small entity is defined as: (1) a small business that meet the definition for business based on SBA size standards; (2) a small governmental jurisdiction that is a government of a city, county, town, school district or special district with a population of less than 50,000; or (3) a small organization that is any not-for-profit enterprise which is independently owned and operated and is not dominant in its field. The following table X.B-1 provides an overview of the primary SBA small business categories potentially affected by this regulation.



Table X.B-1: Primary SBA Small Business Categories  
Potentially Affected by this Proposed Regulation

Industry	NAICS <sup>a</sup> Codes	Defined by SBA as a Small Business If: <sup>b</sup>
Internal Combustion Engines	333618	< 1000 employees
Ship Building	336611	< 1000 employees
Water transportation, freight and passenger	483	<500 employees

NOTES:

a. North American Industry Classification System

b. According to SBA's regulations (13 CFR 121), businesses with no more than the listed number of employees or dollars in annual receipts are considered "small entities" for purposes of a regulatory flexibility analysis.

After considering the economic impacts of today's proposed rule on small entities, I certify that this action will not have a significant economic impact on a substantial number of small entities. Our review of the list of manufacturers of Category 3 marine diesel engines (marine diesel engines at or above 30 l/cyl) indicates that there are no U.S. manufacturers of these engines that qualify as small businesses. We are unaware of any foreign manufacturers of such engines with a U.S.-based facility that would qualify as a small business. In addition, the proposed rule will not impose significant economic impacts on engine manufacturers. Engine manufacturers are already achieving the proposed Tier 1 limits, and our program will impose only negligible compliance costs. With regard to potential Tier 2 standards, we estimate that engine-based requirements may increase the price of an engine by about 9 percent and increase the price of a vessel by about 0.1 percent. Our review of the U.S. shipyards that build, or have built, ships that use Category 3 marine diesel engines indicates that there are no U.S. manufacturers of these ships that qualify as small businesses. Ship operators would have to perform field testing to periodically demonstrate the engine is performing within certified parameters. The testing devices that would be needed to perform field testing are expected to be incorporated in the engine system as delivered by the manufacturer. Operation of these systems is not expected to require significant crew resources since it can be done by crew currently responsible for testing other engine parameters as normally required onboard a vessel to ensure efficient operation of the vessel. Ship operators would also be required to maintain the engine as specified by the engine manufacturer during the useful life of the engine. These costs are not expected to be greater than the costs of maintaining unregulated engines except to the extent that ship operators do not currently maintain engines as specified by the engine manufacturer. Maintenance costs are expected to be minimal given the overall costs of maintaining all of the vessel's systems and structures.

### C. Paperwork Reduction Act

The information collection requirements in this proposed rule have been submitted for approval to the Office of Management and Budget (OMB) under the *Paperwork Reduction Act*,

44 U.S.C. 3501 *et seq.* An Information Collection Request (ICR No. 1897.03) has been prepared by EPA, and a copy may be obtained from Susan Auby, Collection Strategies Division; U.S. Environmental Protection Agency (2822); 1200 Pennsylvania Ave., NW; Washington, DC 20460, by e-mail at [auby.susan@epamail.epa.gov](mailto:auby.susan@epamail.epa.gov), or by calling (202) 566-1672. A copy may also be downloaded from the internet at [www.epa.gov/icr](http://www.epa.gov/icr).

The information being collected is to be used by EPA to ensure that new marine vessels and fuel systems comply with applicable emissions standards through certification requirements and various subsequent compliance provisions.

The estimated annual public reporting and recordkeeping burden for this collection of information is 281 hours per response, with collection required annually. The estimated number of respondents is 6. The total annual cost for the first 3 years of the program is estimated to be \$138,595 per year and includes no annualized capital costs, \$67,000 in operating and maintenance costs, at a total of 1,685 hours per year.

Burden means the total time, effort, or financial resources expended by persons to generate, maintain, retain, disclose, or provide information to or for a federal agency. This includes the time needed to review instructions; develop, acquire, install, and utilize technology and systems for the purposes of collecting, validating, and verifying information, processing and maintaining information, and disclosing and providing information; adjusting the existing ways to comply with any previously applicable instructions and requirements; train personnel to be able respond to a collection of information; search data sources; complete and review the collection of information; and transmit or otherwise disclose the information.

An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations are displayed in 40 CFR part 9 and 48 CFR chapter 15.

Comments are requested on the Agency's need for this information, the accuracy of the provided burden estimates, and any suggested methods for minimizing respondent burden, including through the use of automated collection techniques. Send comments on the ICR to the Director, Collection Strategies Division; U.S. Environmental Protection Agency (2822); 1200 Pennsylvania Ave., NW; Washington, DC 20460; and to the Office of Information and Regulatory Affairs, Office of Management and Budget, 725 17th St., NW, Washington, DC 20503, marked "Attention: Desk Officer for EPA." Include the ICR number in any correspondence. Since OMB is required to make a decision concerning the ICR between 30 and 60 days after **[Insert date of publication in the FEDERAL REGISTER]**, a comment to OMB is best ensured of having its full effect if OMB receives it by **[Insert date 30 days after publication in the FEDERAL REGISTER]**. The final rule will respond to any OMB or public comments on the information collection requirements contained in this proposal.

## **D. Intergovernmental Relations**

### **1. Unfunded Mandates Reform Act**

Title II of the Unfunded Mandates Reform Act of 1995 (UMRA), P.L. 104-4, establishes requirements for Federal agencies to assess the effects of their regulatory actions on State, local, and tribal governments and the private sector. Under section 202 of the UMRA, EPA generally must prepare a written statement, including a cost-benefit analysis, for proposed and final rules with "Federal mandates" that may result in expenditures to State, local, and tribal governments, in the aggregate, or to the private sector, of \$100 million or more in any one year. Before promulgating an EPA rule for which a written statement is needed, section 205 of the UMRA generally requires EPA to identify and consider a reasonable number of regulatory alternatives and adopt the least costly, most cost-effective, or least burdensome alternative that achieves the objectives of the rule. The provisions of section 205 do not apply when they are inconsistent with applicable law. Moreover, section 205 allows EPA to adopt an alternative other than the least costly, most cost-effective, or least burdensome alternative if the Administrator publishes with the final rule an explanation why that alternative was not adopted.

Before EPA establishes any regulatory requirements that may significantly or uniquely affect small governments, including tribal governments, it must have developed under section 203 of the UMRA a small government agency plan. The plan must provide for notifying potentially affected small governments, enabling officials of affected small governments to have meaningful and timely input in the development of EPA regulatory proposals with significant Federal intergovernmental mandates, and informing, educating, and advising small governments on compliance with the regulatory requirements.

EPA has determined that this rule does not contain a Federal mandate that may result in expenditures of \$100 million or more for State, local, and tribal governments, in the aggregate, or the private sector in any one year. According to the cost estimates prepared for this proposal, we estimate the aggregate costs (annualized over 20 years) of the proposed rule to engine manufacturers to be negligible.

Thus, today's rule is not subject to the requirements of sections 202 and 205 of the UMRA.

### **2. Executive Order 13175 (Consultation and Coordination with Indian Tribal Governments)**

Executive Order 13175, entitled "Consultation and Coordination with Indian Tribal Governments" (65 FR 67249, November 6, 2000), requires EPA to develop an accountable process to ensure "meaningful and timely input by tribal officials in the development of regulatory policies that have tribal implications."

This proposed rule does not have tribal implications as specified in Executive Order 13175. This rule will be implemented at the Federal level and impose compliance costs only on engine manufacturers and ship builders. Tribal governments will be affected only to the extent they

purchase and use vessels having regulated engines. Thus, Executive Order 13175 does not apply to this rule. EPA specifically solicits additional comment on this proposed rule from tribal officials.

### **E. National Technology Transfer and Advancement Act**

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (“NTTAA”), Public Law 104-113, section 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs EPA to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards.

This proposed rulemaking involves technical standards for testing emissions from marine diesel engines. EPA proposes to use test procedures contained in the MARPOL NOx Technical Code, with the proposed modifications contained in this rulemaking. The MARPOL NOx Technical Code includes the International Standards Organization (ISO) duty cycle for marine diesel engines (E2, E3, D2, C1) and the American Society for Testing and Materials (ASTM) fuel standards.<sup>61</sup> These procedures are currently used by virtually all Category 3 engine manufacturers to demonstrate compliance with the Annex VI NOx limits and to obtain Statements of Voluntary Compliance to those standards.

With regard to the proposed requirements for field NOx testing and post-installation testing, the Agency conducted a search to identify potentially applicable voluntary consensus standards. However, we identified no such standards. Therefore, EPA proposes to use the procedures contained in the draft regulations for this rulemaking (40 CFR 94.110, 94.1103).

EPA welcomes comments on this aspect of the proposed rulemaking and, specifically, invites the public to identify potentially-applicable voluntary consensus standards and to explain why such standards should be used in this regulation.

### **F. Protection of Children (Executive Order 13045)**

Executive Order 13045, “Protection of Children from Environmental Health Risks and Safety Risks” (62 FR 19885, April 23, 1997) applies to any rule that (1) is determined to be “economically significant” as defined under Executive Order 12866, and (2) concerns an environmental health or safety risk that EPA has reason to believe may have a disproportionate

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<sup>61</sup> The Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines in the Annex VI of MARPOL 73/78 Regulations for the Prevention of Air Pollution from Ships and NOx Technical Code, International Maritime Organization. See footnote 1 regarding how to obtain copies of these documents.

effect on children. If the regulatory action meets both criteria, Section 5-501 of the Order directs the Agency to evaluate the environmental health or safety effects of the planned rule on children, and explain why the planned regulation is preferable to other potentially effective and reasonably feasible alternatives considered by the Agency.

This proposal is not subject to Executive Order 13045 because it is not economically significant under the terms of Executive Order 12866.

#### **G. Federalism (Executive Order 13132)**

Executive Order 13132, entitled “Federalism” (64 FR 43255, August 10, 1999), requires EPA to develop an accountable process to ensure “meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications.” “Policies that have federalism implications” is defined in the Executive Order to include regulations that have “substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government.”

This proposed rule does not have federalism implications. It will not have substantial direct effects on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government, as specified in Executive Order 13132. This proposed rule creates no mandates on State, local or tribal governments. The rule imposes no enforceable duties on these entities, because they do not manufacture any engines that are subject to this rule. This rule will be implemented at the Federal level and impose compliance obligations only on private industry. Thus, Executive Order 13132 does not apply to this rule.

In the spirit of Executive Order 13132, and consistent with EPA policy to promote communications between EPA and State and local governments, EPA specifically solicits comment on this proposed rule from State and local officials.

#### **H. Energy Effects (Executive Order 13211)**

This rule is not a “significant energy action” as defined in Executive Order 13211, “Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use” (66 Fed. Reg. 28355 (May 22, 2001)) because it is not likely to have a significant adverse effect on the supply, distribution or use of energy. The proposed standards have for their aim the reduction of emission from certain marine diesel engines, and have no effect on fuel formulation, distribution, or use. Although the proposal solicits comment on regulating the sulfur content of marine distillate and residual fuel, EPA is not proposing to regulate such fuel at this time.

List of Subjects in 40 CFR part 94

Environmental protection, Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Penalties, Reporting and recordkeeping requirements, Vessels, Warranties.

Dated\_\_\_\_\_

**ORIGINAL DOCUMENT SIGNED BY  
CHRISTINE TODD WHITMAN APRIL 30, 2002**

\_\_\_\_\_  
Christine Todd Whitman,  
Administrator.

For the reasons set out in the preamble, title 40, chapter I of the Code of Federal Regulations is proposed to be amended as follows:

**PART 94 - CONTROL OF AIR POLLUTION FROM MARINE COMPRESSION-IGNITION ENGINES**

1. The authority for part 94 continues to read as follows:

Authority: 42 U.S.C. 7522, 7523, 7524, 7525, 7541, 7542, 7543, 7545, 7547, 7549, 7550, and 7601(a).

**Subpart A — [Amended]**

2. Section 94.1 is amended by revising paragraph (b) to read as follows:

**§94.1 Applicability.**

\* \* \* \* \*

(b) Notwithstanding the provision of paragraph (c) of this section, the requirements and prohibitions of this part do not apply with respect to the engines identified in paragraphs (a)(1) through (3) of this section where such engines are:

- (1) Marine engines with rated power below 37 kW; or
- (2) Marine engines on foreign vessels.

\* \* \* \* \*

3. Section 94.2 is amended by adding definitions to paragraph (b) for "brake-specific fuel consumption", "hydrocarbon standard", "MARPOL Technical Code", "maximum test speed", "residual fuel", "Tier 1", "vessel operator", and "vessel owner", and revising the definitions for "diesel fuel" and "new vessel" to read as follows:

**§94.2 Definitions.**

\* \* \* \* \*

(b) \* \* \*

\* \* \* \* \*

Brake-specific fuel consumption means the mass of fuel consumed by an engine during a test segment divided by the brake-power output of the engine during that same test segment.

\* \* \* \* \*

Diesel fuel means any fuel suitable for use in diesel engines which is commonly or commercially known or sold as diesel fuel or marine distillate fuel.

\* \* \* \* \*

Hydrocarbon standard means an emission standard for total hydrocarbons, nonmethane hydrocarbons, or total hydrocarbon equivalent; or a combined emission standard for NO<sub>x</sub> and total hydrocarbons, nonmethane hydrocarbons, or total hydrocarbon equivalent.

\* \* \* \* \*

MARPOL Technical Code means the "Technical Code on Control of Emission of Nitrogen

Oxides from Marine Diesel Engines" in the "Annex VI of MARPOL 73/78 Regulations for the Prevention of Air Pollution from Ships and NOx Technical Code" from the International Maritime Organization (which is incorporated by reference at §94.5).

\* \* \* \* \*

Maximum test speed means the engine speed defined by §94.107 to be the maximum engine speed to use during testing.

\* \* \* \* \*

New vessel means:

(1) (i) A vessel, the equitable or legal title to which has never been transferred to an ultimate purchaser; or

(ii) A vessel that has been modified such that the value of the modifications exceeds 50 percent of the value of the modified vessel. The value of the modification is the difference in the assessed value of the vessel before the modification and the assessed value of the vessel after the modification. Use the following equation to determine if the fractional value of the modification exceeds 50 percent:

$$\text{Percent of value} = \frac{[(\text{Value after modification}) - (\text{Value before modification})]}{(\text{Value after modification})} \times 100\%$$

(2) Where the equitable or legal title to a vessel is not transferred to an ultimate purchaser prior to its being placed into service, the vessel ceases to be new when it is placed into service.

\* \* \* \* \*

Residual fuel means a petroleum product containing the heavier compounds that remain after the distillate fuel oils (e.g., diesel fuel and marine distillate fuel) and lighter hydrocarbons are distilled away in refinery operations.

\* \* \* \* \*

Tier 1 means relating to an engine subject to the Tier 1 emission standards listed in §94.8.

\* \* \* \* \*

Vessel operator means any individual that physically operates or maintains a vessel, or exercises managerial control over the operation of the vessel.

Vessel owner means the individual or company that holds legal title to a vessel.

\* \* \* \* \*

4. Section 94.5 is amended by revising paragraph (b) to read as follows:

#### **§94.5 Reference materials.**

\* \* \* \* \*

(b) The following paragraphs and tables set forth the material that has been incorporated by reference in this part:

(1) ASTM material. The following table sets forth material from the American Society for Testing and Materials that has been incorporated by reference. The first column lists the number and name of the material. The second column lists the section(s) of the part, other than this section, in which the matter is referenced. The second column is presented for information only and may not be all-inclusive. More recent versions of these standards may be used with advance approval of the Administrator. Copies of these materials may be obtained from American Society for Testing and Materials, 100 Barr Harbor Dr., West Conshohocken, PA 19428. The table follows:



Document number and name	40 CFR part 94 reference
ASTM D 86-97: “Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure”	§94.108 to Subpart D
ASTM D 93-97: “Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester”	§94.108 to Subpart D
ASTM D 129-95: “Standard Test Method for Sulfur in Petroleum Products (General Bomb Method)”	§94.108 A to Subpart D
ASTM D 287-92: “Standard Test Method for API Gravity of Crude Petroleum and Petroleum Products” (Hydrometer Method)	§94.108 to Subpart D
ASTM D 445-97: “Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and the Calculation of Dynamic Viscosity)”	§94.108 to Subpart D
ASTM D 613-95: “Standard Test Method for Cetane Number of Diesel Fuel Oil”	§94.108 to Subpart D
ASTM D 1319-98: “Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption”	§94.108 to Subpart D
ASTM D 2069-91: “Standard Specification for Marine Fuels”	§94.108 to Subpart D
ASTM D 2622-98: “Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry”	§94.108 to Subpart D
ASTM D 3228-92: “Standard Test Method for Total Nitrogen In Lubricating Oils and Fuel Oils By Modified Kjeldahl Method”	§94.108 to Subpart D

Document number and name	40 CFR part 94 reference
ASTM D 5186-96: "Standard Test Method for "Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels and Aviation Turbine Fuels By Supercritical Fluid Chromatography"	§94.108 to Subpart D
ASTM E 29-93a: "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications"	§§94.9, 94.218, 94.305, 94.508

(2) ISO material. The following table sets forth material from the International Organization for Standardization that we have incorporated by reference. The first column lists the number and name of the material. The second column lists the section(s) of the part, other than this section, in which the matter is referenced. The second column is presented for information only and may not be all-inclusive. More recent versions of these standards may be used with advance approval of the Administrator. Copies of these materials may be obtained from International Organization for Standardization, Case Postale 56, CH-1211 Geneva 20, Switzerland. The table follows:

Document number and name	40 CFR part 94 reference
ISO 8178-1: "Reciprocating internal combustion engines – Exhaust emission measurement – Part 1: Test-bed measurement of gaseous and particulate emissions"	§94.109 to Subpart D

(3) MARPOL material. The "Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines" in the "Annex VI of MARPOL 73/78 Regulations for the Prevention of Air Pollution from Ships and NOx Technical Code" from the International Maritime Organization has been incorporated by reference. Copies of this material may be obtained from International Maritime Organization.

5. Section 94.8 is amended by revising paragraphs (a), (c), (d), (e), (f), and (g) to read as follows:

**§94.8 Exhaust emission standards.**

(a) This paragraph (a) contains multiple tiers of emission standards. The Tier 1 standards of paragraph (a)(1) of this section are the earliest tier and apply as specified until the model year that the Tier 2 standards of paragraph (a)(2) of this section (or later standards) become applicable for a given category (or sub-category) of engines.

(1) Tier 1 standards for engines with displacement of 2.5 or more liters per cylinder. (i)

NOx emissions from model year 2004 and later engines with a maximum test speed of 2000 rpm or less may not exceed 18.4 g/kW or the following engine speed-dependent value:  $45.0 \times N^{-0.20} + 1.4$  where N = the maximum test speed of the engine in revolutions per minute. (Note: Speed-dependent standards are rounded to the nearest 0.1 g/kW-hr.)

(ii) NOx emissions from model year 2004 and later engines with a maximum test speed greater than 2000 rpm may not exceed 11.2 g/kW-hr.

(2) Tier 2 standards. Exhaust emissions from marine compression-ignition engines shall not exceed the applicable exhaust emission standards contained in Table A-1 as follows:

Table A-1.– Primary Tier 2 Exhaust Emission Standards (g/kW-hr)

Engine Size liters/cylinder, rated power	Category	Model Year*	THC+NOx g/kW-hr	CO g/kW-hr	PM g/kW-hr
disp. < 0.9 and power ≥ 37 kW	Category 1	2005	7.5	5.0	0.40
0.9 ≤ disp. < 1.2 all power levels	Category 1	2004	7.2	5.0	0.30
1.2 ≤ disp. < 2.5 all power levels	Category 1	2004	7.2	5.0	0.20
2.5 ≤ disp. < 5.0 all power levels	Category 1	2007	7.2	5.0	0.20
5.0 ≤ disp. < 15.0 all power levels	Category 2	2007	7.8	5.0	0.27
15.0 ≤ disp. < 20.0 power < 3300 kW	Category 2	2007	8.7	5.0	0.50
15.0 ≤ disp. < 20.0 power ≥ 3300 kW	Category 2	2007	9.8	5.0	0.50
20.0 ≤ disp. < 25.0 all power levels	Category 2	2007	9.8	5.0	0.50
25.0 ≤ disp. < 30.0 all power levels	Category 2	2007	11.0	5.0	0.50

\* The model years listed indicate the model years for which the specified standards start.

\* \* \* \* \*

(c) In lieu of the THC+NOx standards, and PM standards specified in paragraph (a) of this section, manufacturers may elect to include engine families in the averaging, banking, and trading program, the provisions of which are specified in subpart D of this part. The manufacturer shall then set a family emission limit (FEL) which will serve as the standard for that engine family. The ABT provisions of Subpart D do not apply for Category 3 engines.

(d)(1) Naturally aspirated engines subject to the standards of this section shall not discharge crankcase emissions into the ambient atmosphere.

(2) For engines using turbochargers, pumps, blowers, or superchargers for air induction, if

the engine discharges crankcase emissions into the ambient atmosphere in use, these crankcase emissions shall be included in all exhaust emission measurements. This requirement applies only for engines subject to hydrocarbon standards (e.g., THC standards, NMHC standards, or THC+ NO<sub>x</sub> standards).

(e) (1) For Category 1 and Category 2 engines, exhaust emissions from propulsion engines subject to the standards (or FELs) in paragraph (a), (c), or (f) of this section shall not exceed:

(i) 1.20 times the applicable standards (or FELs) when tested in accordance with the supplemental test procedures specified in §94.106 at loads greater than or equal to 45 percent of the maximum power at rated speed or 1.50 times the applicable standards (or FELs) at loads less than 45 percent of the maximum power at rated speed; or

(ii) 1.25 times the applicable standards (or FELs) when tested over the whole power range in accordance with the supplemental test procedures specified in §94.106

(2) For Category 3 engines, engines must be designed to provide equivalent emission performance over all operating conditions, as specified in §94.205(f).

(f) The following paragraphs define the requirements for low-emitting Blue Sky Series engines.

(1) Voluntary standards. (i) Category 1 and Category 2 engines may be designated “Blue Sky Series” engines by meeting the voluntary standards listed in Table A-2, which apply to all certification and in-use testing.

Table A-2.—Voluntary Emission Standards (g/kW-hr)

Rated Brake Power (kW)	THC+NO <sub>x</sub>	PM
power ≥ 37 kW, and displ.<0.9	4.0	0.24
0.9≤displ.<1.2	4.0	0.18
1.2≤displ.<2.5	4.0	0.12
2.5≤displ.<5	5.0	0.12
5≤displ.<15	5.0	0.16
15 ≤ disp. < 20, and power < 3300 kW	5.2	0.30
15 ≤ disp. < 20, and power ≥ 3300 kW	5.9	0.30
20 ≤ disp. < 25	5.9	0.30
25 ≤ disp. < 30	6.6	0.30

(ii) Category 3 engines may be designated “Blue Sky Series” engines by meeting a voluntary NO<sub>x</sub> standard of  $9.0 \times N^{-0.20} + 1.4$  where N = the maximum test speed of the engine in revolutions per minute (or 4.8 g/kW for engines with maximum test speeds less than 130 rpm). (Note: Speed-dependent standards are rounded to the nearest 0.1 g/kW-hr.) This standard would

apply to all certification and in-use testing.

(2) Additional standards. Blue Sky Series engines are subject to all provisions that would otherwise apply under this part.

(3) Test procedures. Manufacturers may use an alternate procedure to demonstrate the desired level of emission control if approved in advance by the Administrator.

(g) Standards for alternative fuels. The standards described in this section apply to compression-ignition engines, irrespective of fuel, with the following two exceptions for Category 1 and Category 2 engines:

(1) Engines fueled with natural gas shall comply with NMHC+NO<sub>x</sub> standards that are numerically equivalent to the THC+NO<sub>x</sub> described in paragraph (a) of this section; and

(2) Engines fueled with alcohol fuel shall comply with THCE+NO<sub>x</sub> standards that are numerically equivalent to the THC+NO<sub>x</sub> described in paragraph (a) of this section.

6. Section 94.9 is amended by revising paragraphs (a)(1) and (b)(1) to read as follows:

**§94.9 Compliance with emission standards.**

(a) \* \* \*

(1) The minimum useful life is 10 years or 10,000 hours of operation for Category 1, 10 years or 20,000 hours of operation for Category 2, and 3 years or 10,000 hours of operation for Category 3.

\* \* \* \* \*

(b) \* \* \*

(1) Compliance with the applicable emission standards by an engine family shall be demonstrated by the certifying manufacturer before a certificate of conformity may be issued under §94.208. Manufacturers shall demonstrate compliance using emission data, measured using the procedures specified in Subpart B of this part, from a low hour engine. A development engine that is equivalent in design to the marine engines being certified may be used for Category 2 or Category 3 certification.

\* \* \* \* \*

7. Section 94.10 is amended by revising paragraph (a) to read as follows:

**§94.10 Warranty period.**

(a) (1) Warranties imposed by § 94.1107 for Category 1 or Category 2 engines shall apply for a period of operating hours equal to at least 50 percent of the useful life in operating hours or a period of years equal to at least 50 percent of the useful life in years, whichever comes first.

(2) Warranties imposed by § 94.1107 for Category 3 engines shall apply for a period of operating hours equal to at least the full useful life in operating hours or a period of years equal to at least the full useful life in years, whichever comes first.

\* \* \* \* \*

8. Section 94.11 is amended by adding paragraph (g) to read as follows:

**§94.11 Requirements for rebuilding certified engines.**

\* \* \* \* \*

(g) For Tier 1 engines, and all Category 3 engines, the rebuilder and operator shall also comply with the recordkeeping requirements of MARPOL Technical Code (incorporated by reference at §94.5).

9. Section 94.12 is amended by revising the introductory text to read as follows:

**§94.12 Interim provisions.**

This section contains provisions that apply for a limited number of calendar years or model years. These provisions apply instead of other provisions of this part. The provisions of this section do not apply for Category 3 engines.

\* \* \* \* \*

**Subpart B — [Amended]**

10. Section 94.106 is amended by revising the section heading and introductory text to read as follows:

**§ 94.106 Supplemental test procedures for Category 1 and Category 2 marine engines.**

This section describes the test procedures for supplemental testing conducted to determine compliance with the exhaust emission requirements of §94.8(e)(1). In general, the supplemental test procedures are the same as those otherwise specified by this subpart, except that they cover any speeds, loads, ambient conditions, and operating parameters that may be experienced in use. The test procedures specified by other sections in this subpart also apply to these tests, except as specified in this section.

\* \* \* \* \*

11. Section 94.107 is amended by revising paragraph (a) to read as follows:

**§94.107 Determination of maximum test speed.**

(a) Overview. This section specifies how to determine maximum test speed from a lug curve. This maximum test speed is used in §§94.105, 94.106, and 94.109 (including the tolerances for engine speed specified in §94.105).

\* \* \* \* \*

12. Section 94.108 is amended by revising paragraphs (a)(1), (b), and (d)(1), and adding paragraph (e) to read as follows:

**§ 94.108 Test fuels.**

(a) Distillate diesel test fuel. (1) The diesel fuels for testing Category 1 and Category 2 marine engines designed to operate on distillate diesel fuel shall be clean and bright, with pour and cloud points adequate for operability. The diesel fuel may contain nonmetallic additives as follows: cetane improver, metal deactivator, antioxidant, dehazer, antirust, pour depressant, dye, dispersant, and biocide. The diesel fuel shall also meet the specifications (as determined using methods incorporated by reference at §94.5) in Table B-3 of this section, or substantially equivalent specifications approved by the Administrator, as follows:

Table B-3.—Federal Test Fuel Specifications

Item	Procedure (ASTM) <sup>1</sup>	Value (Type 2-D)
Cetane	D 613-95	40-48
Distillation Range:		
IBP, °C	D 86-97	171-204
10% point, °C	D 86-97	204-238
50% point, °C	D 86-97	243-282
90% point, °C	D 86-97	293-332
EP, °C	D 86-97	321-366
Gravity, API	D 287-92	32-37
Total Sulfur, weight%	D 129-95 or D 2622-98	0.03 - 0.80
Hydrocarbon composition:		
Aromatics, % vol.	D 1319-98 or D 5186-96	10 <sup>(2)</sup>
Paraffins, Naphthalenes, Olefins	D 1319-98	<sup>(3)</sup>
Flashpoint, °C (minimum)	D 93-97	54
Viscosity @ 38 °C, Centistokes	D 445-97	2.0-3.2

<sup>1</sup>All ASTM procedures in this table have been incorporated by reference. See §94.6.

<sup>2</sup>Minimum.

<sup>3</sup>Remainder.

\* \* \* \* \*

(b) Other fuel types. For Category 1 and Category 2 engines that are designed to be capable of using a type of fuel (or mixed fuel) instead of or in addition to distillate diesel fuel (e.g., natural gas, methanol, or nondistillate diesel), and that are expected to use that type of fuel (or mixed fuel) in service:

(1) A commercially available fuel of that type shall be used for exhaust emission testing. The manufacturer shall propose for the Administrator's approval a set of test fuel specifications that take into account the engine design and the properties of commercially available fuels. The Administrator may require testing on each fuel if it is designed to operate on more than one fuel. These test fuel specifications shall be reported in the application for certification.

(2) NO<sub>x</sub> emissions may be adjusted to account for the nitrogen concentration of the fuel (as measured by ASTM D 3228-92). The adjusted NO<sub>x</sub> emissions shall be calculated using the following equation:

$$\text{Adjusted NO}_x \text{ emissions [g/kW-hr]} = \text{NO}_x - [\text{BSFC} * 3.25 * (\text{FNF})]$$

Where:

NO<sub>x</sub>=measured weighted NO<sub>x</sub> level [g/KW-hr].

BSFC=measured brake specific fuel consumption [g/KW-hr].

FNF=fuel nitrogen weight fraction.

\* \* \* \* \*

(d) Correction for sulfur. (1) Particulate emission measurements from Category 1 or Category 2 engines without exhaust aftertreatment obtained using a diesel fuel containing more than 0.40 weight percent sulfur may be adjusted to a sulfur content of 0.40 weight percent.

\* \* \* \* \*

(e) Test Fuel for Category 3. (1) Except as specified in paragraph (e)(4) of this section, or allowed by paragraph (e)(2) of this section, the test fuel for Category 3 marine engines shall:

(i) Be a residual fuel meeting the ASTM D 2069-91 specification for RMH-55 grade of fuel but not for RMC-10 grade of fuel.

(ii) Have a nitrogen content of 0.6 percent by weight or less.

(2) Marine distillate fuel may be used for certification testing.

(3) NO<sub>x</sub> emissions shall be adjusted to account for the nitrogen concentration of the fuel (as measured by ASTM D 3228-92). The adjusted NO<sub>x</sub> emissions shall be calculated using the following equation:

$$\text{Adjusted NO}_x \text{ emissions [g/kW-hr]} = \text{NO}_x - [\text{BSFC} * 3.25 * (\text{FNF}-0.0040)]$$

Where:

NO<sub>x</sub>=measured weighted NO<sub>x</sub> level [g/KW-hr].

BSFC=measured brake specific fuel consumption [g/KW-hr].

FNF=fuel nitrogen weight fraction.

(4) For engines that are designed to be capable of using a type of fuel (or mixed fuel) instead of or in addition to residual fuel (e.g., natural gas), and that are expected to use that type of fuel (or mixed fuel) in service, a commercially available fuel of that type shall be used for exhaust emission testing. The manufacturer shall propose for the Administrator's approval a set of test fuel specifications that take into account the engine design and the properties of commercially available fuels. The Administrator may require testing on each fuel if it is designed to operate on more than one fuel. These test fuel specifications shall be reported in the application for certification.



13. A new §94.109 is added to subpart B to read as follows:

**§ 94.109 Test procedures for Category 3 marine engines.**

(a) Gaseous emissions shall be measured using the test procedures specified by Section 5 of the MARPOL Technical Code (incorporated by reference at §94.5), except as otherwise specified in this paragraph (a).

- (1) The inlet air and exhaust restrictions shall be set at the average in-use levels.
- (2) Measurements are valid only for sampling periods in which the temperature of the charge air entering the engine is within 3°C of the temperature that would occur in-use under ambient conditions (temperature, pressure, and humidity) identical to the test conditions. You may measure emissions within larger discrepancies, but you may not use those measurements to demonstrate compliance with these regulations.
- (3) Engine coolant and engine oil temperatures shall be equivalent to the temperatures that would occur in-use under ambient conditions identical to the test conditions.
- (4) Exhaust flow rates shall be calculated using measured fuel flow rates.
- (5) Standards used for calibration shall be traceable to NIST standards. (Other national standards may be used if they have been shown to be equivalent to NIST standards.)
- (6) Tests may be performed at any representative pressure and humidity levels. Tests may be performed at any ambient air temperature from 13°C to 30°C and any charge air cooling water temperature from 17°C to 27°C.
- (7) The test fuel shall be a residual fuel meeting the specifications of §94.108. Distillate fuel may be used for certification testing. Emissions shall be corrected for the nitrogen content of the fuel, according to §94.108(e)(3).
- (8) Test cycles shall be denormalized based on the maximum test speed described in §94.107.

(b) Analyzers meeting the specifications of either 40 CFR part 86, subpart N, or ISO 8178-1 shall be used to measure THC and CO.

(c) The Administrator may specify changes to the provisions of paragraph (a) of this section that are necessary to comply with the general provisions of § 94.102.

14. A new §94.110 is added to subpart B to read as follows:

**§ 94.110 Test procedures for verifying emission performance of Category 3 marine engines installed in a vessel.**

The test procedures of this section are designed to verify emissions performance of engines that have been installed in a vessel (and thus cannot be tested using an engine dynamometer). These procedures shall be used by vessel operators to verify compliance with the requirements of §§94.1003 and 94.1004. EPA may allow the use of these test procedures for other compliance demonstrations. For example, we will allow a manufacturer to use these test procedures to meet the production testing requirements of subpart F, as long as they have been demonstrated to

provide an equivalent demonstration of compliance to testing conducted in accordance with the test procedures of §94.109.

(a) General requirement. All test systems shall be designed according to good engineering judgment to ensure accurate verification that the engine is complying with the requirements of this part.

(b) Equipment. The measurement system shall be permanently installed in the vessel, and shall include the following:

(1) A NO<sub>x</sub> analyzer with an accuracy of  $\pm 2$  percent of point or better, and a precision of  $\pm 5$  percent of point or better, under steady-state laboratory conditions. The analyzer must reach at least 90 percent of its final response within 5.0 seconds after any step change to the input concentration greater than or equal 80 percent of full scale.

(2) An engine speed gauge with an accuracy and precision of  $\pm 0.1$  rpm or better under steady-state laboratory conditions.

(3) An engine output shaft torque gauge with an accuracy and precision of  $\pm 2$  percent of point or better under steady-state laboratory conditions.

(4) Other sensors as necessary to determine the operational conditions of the engine, such as a thermocouple in the exhaust stream.

(c) Data logging. The measurement system shall automatically log all test results and other test parameters. The data logger must also automatically log all adjustments to the engine that could affect emissions. The position of the vessel (e.g., longitude and latitude) must be recorded with all logs of test results and adjustments.

(d) Calibration. The measurement system shall include ports for zero and span gases. The analyzers shall be zeroed and spanned prior to each test. Full calibration of the system must be conducted as needed, according to good engineering judgment.

(e) Test run. The NO<sub>x</sub> concentration in the exhaust shall be measured under normal operating conditions. Engine speed, engine torque, and other test parameters shall be measured simultaneously.

(f) Compliance. The measured NO<sub>x</sub> concentration shall be compared to a table or algorithm supplied by the engine manufacturer. If the NO<sub>x</sub> concentration is at or below the level specified by the engine manufacturer for the test conditions (e.g., engine speed, engine torque, seawater temperature, nitrogen content of the fuel, etc.), then the engine is in compliance with the manufacturer specifications. If the NO<sub>x</sub> concentration is above the level specified by the engine manufacturer for the test conditions, then the engine is not in compliance, and must be readjusted and retested.

## **Subpart C — [Amended]**

15. Section 94.203 is amended by revising paragraph (d)(14) to read as follows:

### **§94.203 Application for certification.**

\* \* \* \* \*

(d) \* \* \*

(14) (i) For Category 1 and Category 2 engines, a statement that the all the engines included in the engine family comply with the Not To Exceed standards specified in §94.8(e) when

operated under all conditions which may reasonably be expected to be encountered in normal operation and use; the manufacturer also must provide a detailed description of all testing, engineering analyses, and other information which provides the basis for this statement.

(ii) For Category 3 engines, a statement that the all the engines included in the engine family comply with the requirements of §94.8(e) when operated under all conditions which may reasonably be expected to be encountered in normal operation and use; the manufacturer must also provide a detailed description of all testing, engineering analyses, and other information which provides the basis for this statement.

\* \* \* \* \*

16. Section 94.204 is amended by adding paragraph (f) to read as follows:

**§94.204 Designation of engine families.**

\* \* \* \* \*

(f) Category 3 engines shall be grouped into engine families as specified in Section 4.3 of the MARPOL Technical Code (incorporated by reference at §94.5), except as allowed in paragraph (d) and (e) of this section.

17. Section 94.205 is amended by revising paragraph (b) and adding paragraphs (e) and (f) to read as follows:

**§94.205 Prohibited controls, adjustable parameters.**

\* \* \* \* \*

(b) (1) Category 1 and Category 2 marine engines equipped with adjustable parameters must comply with all requirements of this subpart for any adjustment in the physically adjustable range.

(2) Category 3 marine engines equipped with adjustable parameters must comply with all requirements of this subpart for any adjustment specified in paragraph (e) of this section

\* \* \* \* \*

(e) The following provisions apply for Category 3 marine engines:

(1) For certification testing, engines shall be adjusted according to the manufacturer's specifications.

(2) Manufacturers shall determine NO<sub>x</sub> concentration targets for in-use testing, consistent with the provisions of paragraph (f) of this section, that enable the operator to ensure that the engine is properly adjusted in use.

(3) For production line testing and in-use testing, the engine shall be adjusted so that measured NO<sub>x</sub> concentration in the exhaust is no higher than engine manufacturer's target described in paragraph (e)(2) of this section.

(f) For Category 3 marine engines, manufacturers must specify in the maintenance instructions how to adjust the engines to achieve emission performance equivalent to the performance demonstrated under the certification test conditions. This must address all necessary adjustments, including those required to address differences in fuel quality or ambient temperatures. Note: The engine must comply with the applicable emission standards of §94.8 for

all conditions allowed by the test procedures described in §94.109.

(1) Equivalent emissions performance is measured relative to optimal engine performance that could be achieved in the absence of emission standards (i.e., the calibration that result in the lowest fuel consumption and/or maximum firing pressure). Except as allowed by paragraphs (f)(2) and (f)(3) of this section, equivalent performance requires the same percent reduction in NOx emissions from the optimal calibration as is achieved under the test conditions.

(2) The adjustments may achieve a smaller reduction in NOx emissions under some conditions if the engine is calibrated the same at the different conditions. For example, if the engine uses injection timing retard and EGR to reduce emissions, then the manufacturer would need to retard timing the same number of degrees and use the same rate of EGR at the different conditions in order to qualify for the allowance in this paragraph (f)(2).

(3) Under extraordinary circumstances, the manufacturer may petition EPA during certification to allow calibrations not meeting requirements of paragraph (f)(1) or (f)(2) of this section if the manufacturer demonstrates that compliance with those requirements is not feasible. If the manufacturer can comply with those requirements by derating the engine, then compliance is considered to be feasible.

(4) Adjustments must achieve equivalent performance for all engine speeds other than the speeds associated with the certification test points. For engine speeds between test point speeds, this means that NOx emissions should generally follow a linear interpolation between test points.

(5) Example: If, for the test calibration, you retard the start of injection timing by 2.0 degrees for the maximum test speed to reduce NOx emissions by 18 percent, and you retard the start of injection timing by 3.0 degrees for all other speeds to reduce NOx emissions by 25 percent, then for all other operational conditions:

(i) For maximum engine speed, you must either retard timing by 2.0 degrees or reduce NOx emissions by 18 percent or more relative to the calibration that would be used in the absence of emissions standards; and

(ii) For other speeds, you must either retard timing by 3.0 degrees or reduce NOx emissions by 25 percent or more relative to the calibration that would be used in the absence of emissions standards.

18. Section 94.209 is amended by adding introductory text before paragraph (a) to read as follows:

**§94.209 Special provisions for post-manufacture marinizers.**

The provisions of this section apply for Category 1 and Category 2 engines, but not for Category 3 engines.

\* \* \* \* \*

19. Section 94.211 is amended by revising paragraphs (h) introductory text and (j)(2), and adding paragraphs (a)(3) and (e)(2)(iii) to read as follows:

**§94.211 Emission-related maintenance instructions for purchasers.**

(a) \* \* \*

(3) For Category 3 engines, the manufacturer must provide in boldface type on the first page of the written maintenance instructions notice that §94.1004 requires that the emissions-related maintenance be performed as specified in the instructions (or equivalent).

\* \* \* \* \*

(e) \* \* \*

(2) \* \* \*

(iii) The maintenance intervals listed in paragraphs (e)(3) and (e)(4) of this section do not apply for Category 3.

\* \* \* \* \*

(h) For Category 1 and Category 2 engines, equipment, instruments, or tools may not be used to identify malfunctioning, maladjusted, or defective engine components unless the same or equivalent equipment, instruments, or tools will be available to dealerships and other service outlets and are:

\* \* \* \* \*

(j) \* \* \*

(2) All critical emission-related scheduled maintenance must have a reasonable likelihood of being performed in use. For Category 1 and Category 2 engines, the manufacturer must show the reasonable likelihood of such maintenance being performed in-use. Critical emission-related scheduled maintenance items which satisfy one of the conditions defined in paragraphs (j)(2)(i) through (j)(2)(vi) of this section will be accepted as having a reasonable likelihood of being performed in use.

20. Section 94.214 is revised to read as follows:

#### **§94.214 Production engines.**

Any manufacturer obtaining certification under this part shall supply to the Administrator, upon his/her request, a reasonable number of production engines, as specified by the Administrator. The engines shall be representative of the engines, emission control systems, and fuel systems offered and typical of production engines available for sale or use under the certificate. These engines shall be supplied for testing at such time and place and for such reasonable periods as the Administrator may require. This requirement does not apply for Category 3 engines. Manufacturers of Category 3 engines, however, must allow EPA access to test engines and development engines to the extent necessary to determine that the engine family is in full compliance with the applicable requirements of this part.

21. Section 94.217 is amended by adding paragraph (f) to read as follows:

#### **§94.217 Emission data engine selection.**

\* \* \* \* \*

(f) A single cylinder test engine may be used for certification of Category 3 engine families.

22. Section 94.218 is amended by revising paragraph (d)(1) to read as follows:

**§94.218 Deterioration factor determination.**

\* \* \* \* \*

(d) \* \* \*

(1) Except as allowed by paragraph (d)(2) of this section, the manufacturer shall determine the deterioration factors for Category 1 and Category 2 engines based on service accumulation and related testing, according to the manufacturer's procedures, and the provisions of §§94.219 and 94.220. The manufacturer shall determine the form and extent of this service accumulation, consistent with good engineering practice, and shall describe this process in the application for certification.

\* \* \* \* \*

23. Section 94.219 is amended by revising paragraph (a) to read as follows:

**§94.219 Durability data engine selection.**

(a) For Category 1 and Category 2 engines, the manufacturer shall select for durability testing, from each engine family, the engine configuration which is expected to generate the highest level of exhaust emission deterioration on engines in use, considering all exhaust emission constituents and the range of installation options available to vessel builders. The manufacturer shall use good engineering judgment in making this selection.

\* \* \* \* \*

**Subpart E — [Amended]**

24. Section 94.403 is amended by revising paragraph (a) to read as follows:

**§94.403 Emission defect information report.**

(a) A manufacturer must file a defect information report whenever it determines, in accordance with procedures it established to identify either safety-related or performance defects (or based on other information), that a specific emission-related defect exists in 25 or more Category 1 marine engines, or 10 or more Category 2 marine engines, or 2 or more Category 3 engines or cylinders. No report must be filed under this paragraph for any emission-related defect corrected prior to the sale of the affected engines to an ultimate purchaser. (Note: These limits apply to the occurrence of the same defect, and are not constrained by engine family or model year.)

\* \* \* \* \*

## **Subpart F — [Amended]**

25. Section 94.503 is amended by revising paragraphs (a) and (b), and adding paragraph (d) to read as follows:

### **§94.503 General Requirements**

(a) For Category 1 and Category 2 engines, manufacturers shall test production line engines in accordance with sampling procedures specified in §94.505 and the test procedures specified in §94.506.

(b) Upon request, the Administrator may also allow manufacturers to conduct alternate production line testing programs for Category 1 and Category 2 engines, provided the Administrator determines that the alternate production line testing program provides equivalent assurance that the engines that are being produced conform to the provisions of this part. As part of this allowance or for other reasons, the Administrator may waive some or all of the requirements of this subpart.

\* \* \* \* \*

(d) For Category 3 engines, the manufacturer shall test each production engine after it is installed in the vessel. The manufacturer may use the test procedures specified in §94.109, or alternate test procedures that provide an equivalent demonstration of production quality. For example, a manufacturer may use the short test procedures of §94.110, as long as the procedures can be demonstrated to provide an equivalent demonstration of compliance to testing conducted in accordance with the test procedures of §94.109.

26. Section 94.505 is amended by revising paragraph (a) introductory text to read as follows:

### **§94.505 Sample selection for testing.**

(a) At the start of each model year, the manufacturer will begin to select engines from each Category 1 and Category 2 engine family for production line testing. Each engine will be selected from the end of the production line. Testing shall be performed throughout the entire model year to the extent possible. Engines selected shall cover the broadest range of production possible. Note: Each Category 3 production engine must be tested.

\* \* \* \* \*

27. Section 94.507 is amended by revising paragraph (a) to read as follows:

### **§94.507 Sequence of testing.**

(a) If one or more Category 1 or Category 2 engines fail a production line test, then the manufacturer must test two additional engines for each engine that fails.

\* \* \* \* \*

28. Section 94.508 is amended by revising paragraphs (d) and (e) introductory text to read as

follows:

**§94.508 Calculation and reporting of test results.**

\* \* \* \* \*

(d) (1) If, subsequent to an initial failure of a Category 1 or Category 2 production line test, the average of the test results for the failed engine and the two additional engines tested, is greater than any applicable emission standard or FEL, the engine family is deemed to be in non-compliance with applicable emission standards, and the manufacturer must notify the Administrator within 2 working days of such noncompliance.

(2) If a Category 3 engine fails a production line test, the engine family is deemed to be in non-compliance with applicable emission standards, and the manufacturer must notify the Administrator within 2 working days of such noncompliance.

(e) Within 30 calendar days of the end of each quarter in which production line testing occurs, each manufacturer must submit to the Administrator a report which includes the following information:

\* \* \* \* \*

29. Section 94.510 is amended by revising paragraph (b) and adding paragraph (c) to read as follows:

**§94.510 Compliance with criteria for production line testing.**

\* \* \* \* \*

(b) A Category 1 or Category 2 engine family is deemed to be in noncompliance, for purposes of this subpart, if at any time throughout the model year, the average of an initial failed engine and the two additional engines tested, is greater than any applicable emission standard or FEL.

(c) For Category 3 engines, the engine family is deemed to be in noncompliance, for purposes of this subpart, whenever the average emission rate of any regulated pollutant is greater than the applicable emission standard for any test engine.

**Subpart I — [Amended]**

30. Section 94.801 is amended by revising paragraph (b) to read as follows:

**§94.801 Applicability.**

\* \* \* \* \*

(b) Regulations prescribing further procedures for the importation of engines into the Customs territory of the United States are set forth in U.S. Customs Service regulations (19 CFR Chapter I).

**Subpart J — [Amended]**



31. Section 94.904 is amended by removing paragraph (b)(7).

32. Section 94.906 is amended by revising the section heading and removing paragraph (d) to read as follows:

**§94.906 Manufacturer-owned exemption, display exemption, and competition exemption.**

\* \* \* \* \*

33. Section 94.907 is amended by revising paragraph (d) introductory text to read as follows:

**§94.907 Engine dressing exemption.**

\* \* \* \* \*

(d) New Category 1 and Category 2 marine engines that meet all the following criteria are exempt under this section:

\* \* \* \* \*

34. Subpart K is added consisting of §§94.1001, 94.1002, 94.1003, and 94.1004 to read as follows:

**Subpart K - Requirements Applicable to Vessel Manufacturers, Owners, and Operators**  
Sec.

94.1001 Applicability.

94.1002 Definitions.

94.1003 Production and in-use testing.

94.1004 Maintenance, repair and adjustment.

**Subpart K - Requirements Applicable to Vessel Manufacturers, Owners, and Operators.**

**§94.1001 Applicability.**

The requirements of this subpart are applicable to manufacturers, owners, and operators of marine vessels that contain Category 3 engines subject to the provisions of subpart A of this part, except as otherwise specified.

**§94.1002 Definitions.**

The definitions of subpart A of this part apply to this subpart.

**§94.1003 Production and in-use testing.**

(a) Production testing. Vessel manufacturers must allow engine manufacturers to conduct the production line testing required by subpart F of this part.

(b) In-use adjustments. Operators of in-use engines may adjust certified engines as specified by the engine manufacturer, provided that after the adjustment the engine's exhaust

emissions are measured to verify that the engine is operating within the specifications certified by the manufacturer. For the purposes of this section, maintenance is considered to be a form of adjustment.

(1) Emissions shall be measured using the short-test procedures specified in §94.110, or other test procedures that provide an equivalent demonstration of compliance.

(2) (i) This paragraph (b)(2)(i) applies for vessels adjusted within 175 nautical miles of the United States coastline entering or leaving a port of the United States. Operators of vessels whose next port of call is a port of the United States, and operators of vessels that leaving a port of the United States, must ensure that the engine is operating according to the certifying manufacturer's specification after any adjustments are made to its engine within 175 nautical miles of the coastline of the United States. Operators shall verify that the engine is operating within the specifications certified by the manufacturer by measuring the engine's exhaust emissions in accordance with paragraph (b)(1) of this section.

(ii) This paragraph (b)(2)(ii) applies for vessels adjusted beyond 175 nautical miles of the United States coastline that will enter a port of the United States. Operators of vessels whose next port of call is a port of the United States must ensure that the engine is operating according to the certifying manufacturer's specification before coming within 175 nautical miles of the coastline of the United States. Operators shall verify that the engine is operating within the specifications certified by the manufacturer by measuring the engine's exhaust emissions in accordance with paragraph (b)(1) of this section.

(3) All adjustments and verification testing must be recorded. These records must be made available to EPA upon request.

(4) The requirements of this paragraph (b) do not apply for adjustments that could not affect emissions.

(5) For the purposes of this section the "coastline of the United States" is the baseline from which the territorial sea of the United States is measured.

(c) Other testing. Manufacturers, owners and operators must allow emission tests to be conducted by the U.S. government, and must provide reasonable assistance to perform such tests.

#### **§94.1004 Maintenance, repair, and adjustment.**

(a) Unless otherwise approved by the Administrator, all owners and operators of Category 3 engines subject to the provisions of this part shall ensure that all emission-related maintenance is performed, as specified in the maintenance instructions provided by the certifying manufacturer in compliance with § 94.211 (or maintenance that is equivalent to the maintenance specified by the certifying manufacturer in terms of maintaining emissions performance). Owners or operators performing equivalent maintenance must have a reasonable technical basis for believing that the maintenance is equivalent to that described in the application for certification.

(b) Unless otherwise approved by the Administrator, all maintenance and repair of Category 3 engines subject to the provisions of this part performed by any owner, operator or other maintenance provider, including maintenance that is not covered by paragraph (a) of this section, shall be performed, using good engineering judgement, in such a manner that the engine continues (after the maintenance or repair) to meet the emission standards it was certified as meeting prior to the need for maintenance or repair.

(c) All adjustments of certified engines shall be performed as specified by the engine manufacturer, unless the vessel is operating beyond 175 nautical miles of the United States coastline. As is described in §94.1003 (b), engines on vessels operating beyond 175 nautical miles of the United States coastline that are adjusted outside of the manufacturer's specifications, and that will enter a port of the United States, must be adjusted according to the engine manufacturer's specification before coming within 175 nautical miles of the United States coastline. For the purposes of this paragraph, the "coastline of the United States" is the baseline from which the territorial sea of the United States is measured.

(d) The owner of the engine shall maintain records of all maintenance and repair that could reasonably affect the emission performance of any Category 3 engine subject to the provision of this part.

### **Subpart L — [Amended]**

35. Section 94.1103 is amended by revising paragraph (a)(3)(i), and adding paragraphs (a)(2)(v) and (a)(7) to read as follows:

#### **§94.1103 Prohibited acts.**

(a) \* \* \*

(2) \* \* \*

(v) For an owner or operator of a vessel using a Category 3 to refuse to allow the in-use testing described in § 94.1003 to be performed.

(3)(i) For a person to remove or render inoperative a device or element of design installed on or in a engine in compliance with regulations under this part, or to set any adjustable parameter to a setting outside of the range specified by the manufacturer, as approved in the application for certification by the Administrator (except as allowed by §§ 94.1003 and 94.1004).

\* \* \* \* \*

(7)(i) For an owner or operator of a vessel using a Category 3 engine to fail or refuse to ensure that an engine is in compliance and is properly adjusted as set forth in §§ 94.1003 and 94.1004, (including a failure or refusal to conduct the required verification testing or keep the required records).

(ii) For a an owner or operator of a vessel using a Category 3 to fail to maintain or repair an engine as set forth in § 94.1004.

\* \* \* \* \*

36. Section 94.1106 is amended by revising paragraphs (a)(1), (a)(4), and (a)(5) to read as follows:

#### **§94.1106 Penalties.**

(a) \* \* \*

(1) A person who violates §94.1103(a)(1), (a)(4), (a)(5), (a)(6), or (a)(7) or a manufacturer or dealer who violates §94.1103(a)(3)(i) or (iii) is subject to a civil penalty of not more than \$25,000 for each violation unless modified by the Debt Collection Improvement Act and/or

regulations issued there under.

\* \* \* \* \*

(4) A violation with respect to §94.1103(a)(3)(ii) constitutes a separate offense with respect to each part or component. Each day of a violation with respect to §94.1103(a)(5) or (a)(7) constitutes a separate offense.

(5) A person who violates §94.1103(a)(2), (a)(5) or (a)(7) is subject to a civil penalty of not more than \$25,000 per day of violation unless modified by the Debt Collection Improvement Act and/or regulations issued there under.

\* \* \* \* \*

37. Section 94.1108 is amended by adding paragraph (d) to read as follows:

**§94.1108 In-use compliance provisions.**

\* \* \* \* \*

(d) The U.S. Customs Service or the U.S. Coast Guard may require the operator of any vessel that is subject to the provisions of this part to certify in writing that all of the vessel's engines conform to the applicable provisions of this part.